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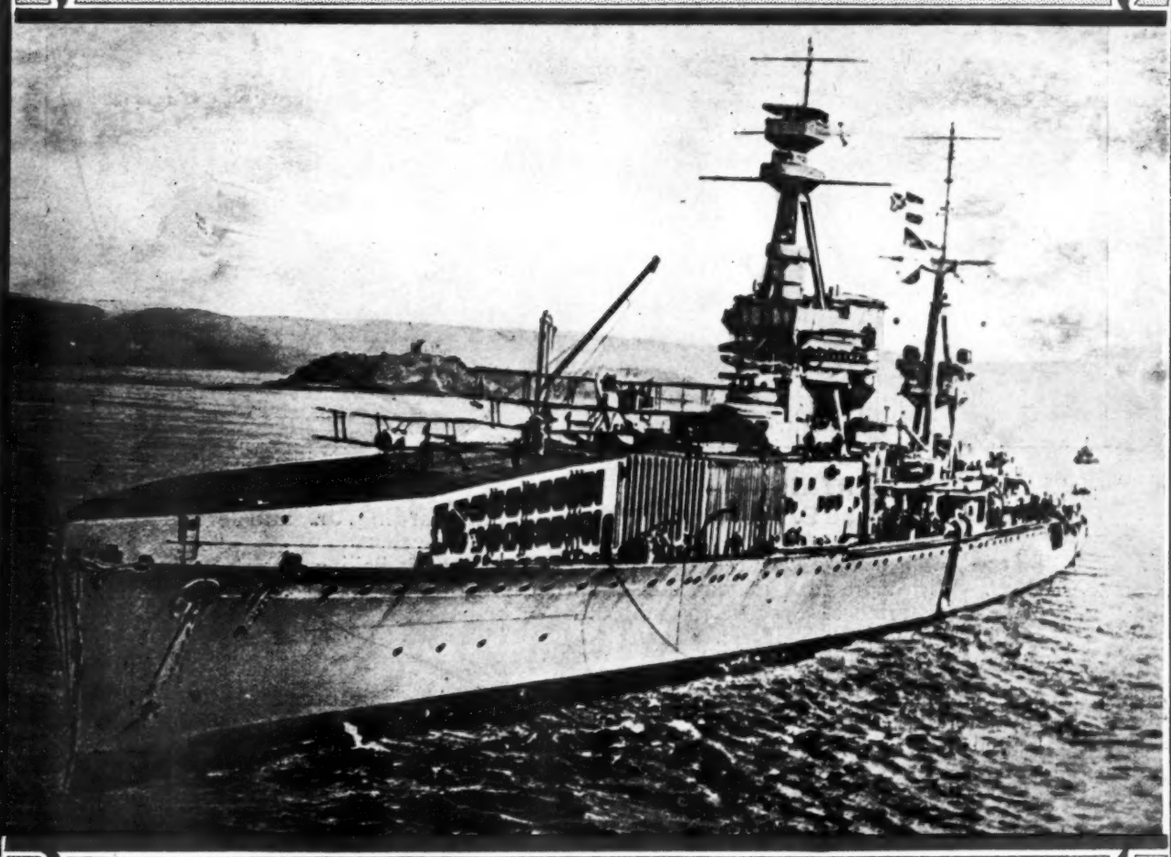

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VOLUME VII
No. 10

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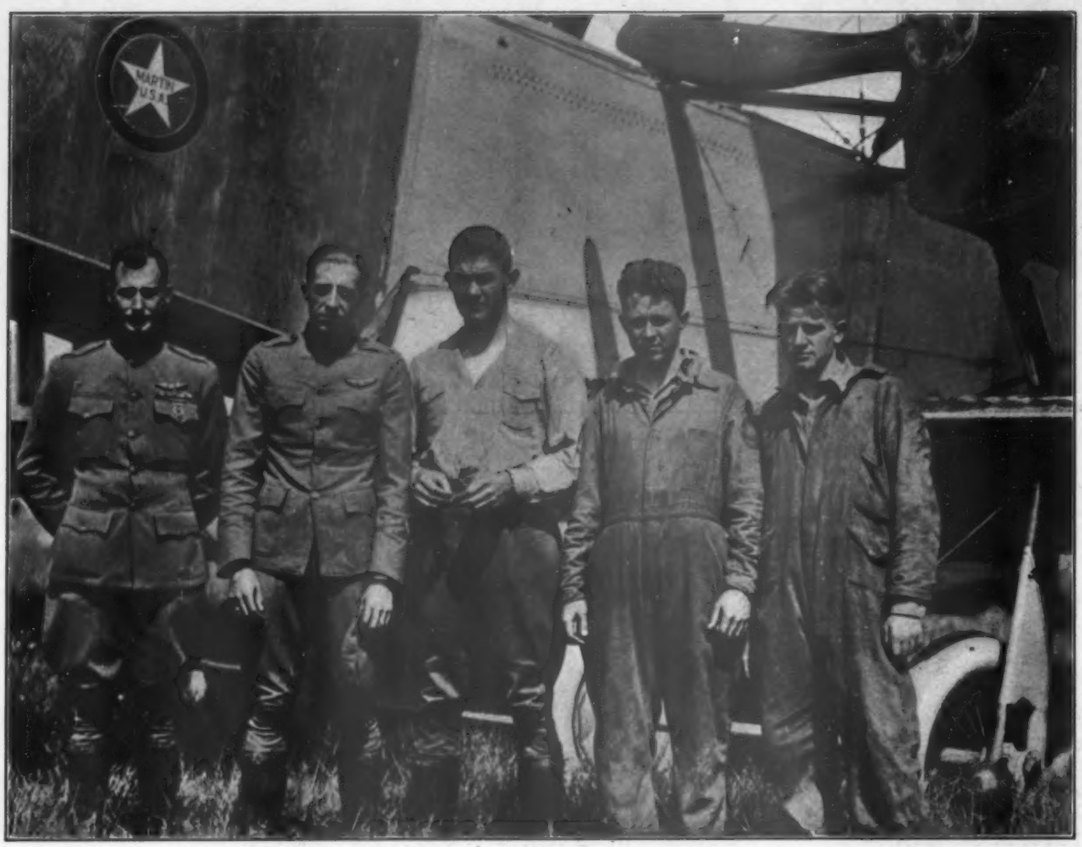

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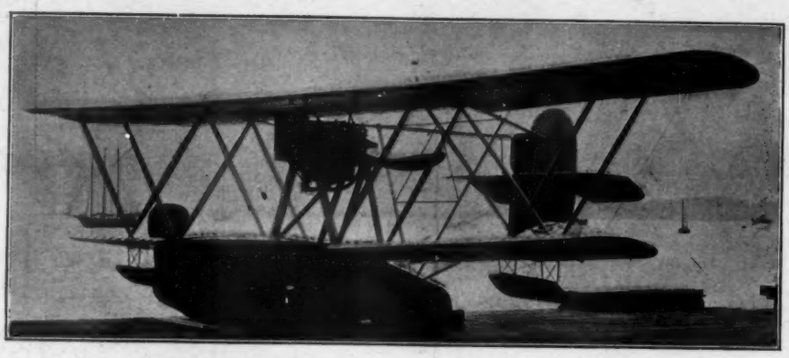

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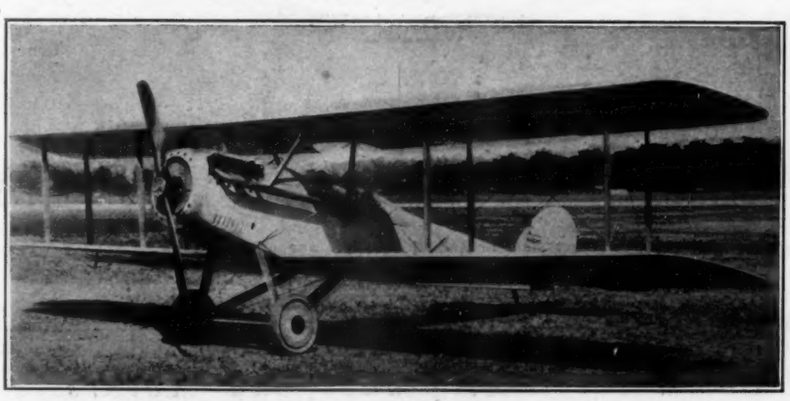

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AVIATION
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VOL. VII. NO. 01

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THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*

HARTFORD BUILDING, UNION SQUARE, 22 EAST SEVENTEENTH STREET, NEW YORK

WASHINGTON OFFICE, EVENING STAR BUILDING

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Vol. VII | December 15, 1919 | No. 10

THE practical possibilities of an amphibian airplane are so important that in all probability much experimental work will be conducted along these lines in the next few years. A machine that could take off at a flying field and alight on the water, or vice versa, would have the effect of bringing aerial passenger transport into general use much quicker than by the joint employment of land and seaplanes as at present.

The saving in time would be the most important advantage. In leaving New York, Chicago, Boston or other large cities, the amphibian airplane could rise from the water very close to the center of the city—an impossibility now owing to the lack of centrally located landing fields. At the conclusion of its trip the machine would find a landing place either at a field or on a near-by river or lake. The resultant saving in time and inconvenience would be sufficiently important to make of the development of such a flying machine a worthy goal for engineering achievement.

The Navy specifications for amphibian flying machines, which are printed in this issue, are a proof that such machines also possess distinct value for naval operations, particularly in fleet work. That the Navy should come out boldly for "mixed" flying machines at a time when this question is still a subject of great controversy among aeronautical engineers, merely shows that the Bureau of Construction and Repair of the Navy Department intends to continue, as heretofore, to direct and stimulate aeronautical development along lines of sound progression.

The Alerion and the Aviette

More definite information is available with regard to the so-called "Alerion," recently developed by two French engineers and patents for which have been bought by the French Government At the same time a fairly detailed description is available of the "Aviette" developed by Gabriel Poulain.

The "Alerion" is a very simple machine. The body is built exactly like that of an airplane with rear skid, landing wheels, and rudder. The chief novelty is that the entire force of sustentation is provided by twin propellers driven by two motors. A joy stick allows longitudinal and lateral equilibrium to be maintained, and the propellers to be placed in such a position that they may give propulsion as well as sustentation. If one motor stops, the apparatus linking them is such that flight is assured by the remaining motor. If both motors fail the wing-like blades of the propeller, 360 sq. ft. in area, are expected to behave like an air brake, revolving independently and permitting the machine to land safely.

In the Aviette a special streamlined bicycle is fitted with a set of wings whose angle of incidence can be varied. Once the bicycle is under way with pedal power, the wings are set at the position of minimum resistance and a jump of some length can be made.

Even though a great deal of experimentation yet remains to be done on both these extraordinary machines, it is encouraging to hear of them. French inventive genius is great and daring, and novel machines such as these may survive the first difficult and critical stages and blaze the way for new aeronautical triumphs.

The English Air Mail

The American Air Mail has lately had a successful imitator in the English Air Mail. We say has had, because this service was only an emergency service organized to meet the postal congestion due to the railway strike. While a prohibitive charge of two shillings an ounce was made for mail, and arrangements were made in a great hurry, the service was entirely successful. Forty-six airplanes in all were used and mail was carried to all parts of England, but also to Belgium, Holland, Norway and Denmark.

There could be no better proof that the air mail is not an experimental venture, but a service which, once adopted, will continue to grow in Europe just as it does in the United States.

The Chicago Aero Show

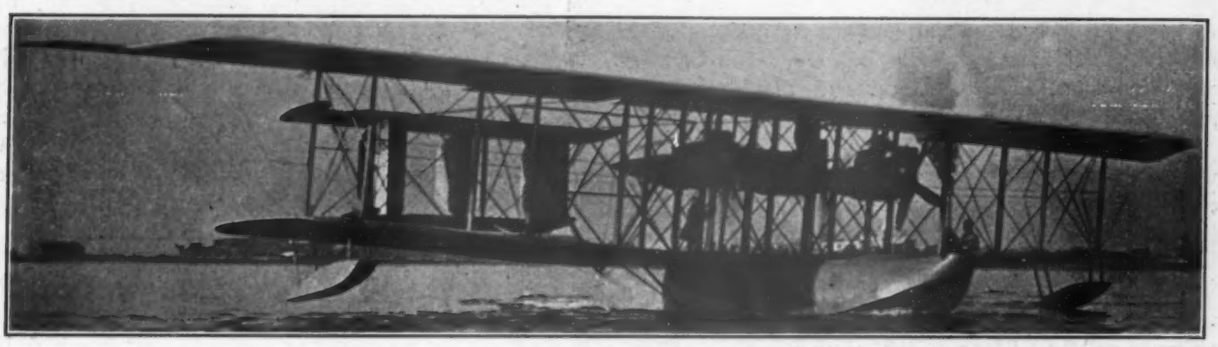
Chicago will be the center of American aeronautical activities in January, when the aeronautical exposition organized by the Manufacturers' Aircraft Association opens in the great metropolis of the Middle West.

That the undertaking will be a success is certain, as practically all the leading aircraft manufacturers will be represented by comprehensive exhibits. Thousands of visitors will thus have an opportunity of examining the latest products of our aircraft industry. For many visitors the exposition will be a revelation as to the state of finality aircraft has attained in the last few years and no doubt the number of enthusiasts of flying—and of potential purchasers of aircraft—will increase as a consequence.

The great distances between centers of population and long stretches of flat country found in the Middle West afford a fruitful field for the exploitation of aerial transport services and the general interest displayed in that section of the country towards aviation is therefore logical.

Development of U. S. Naval Aviation*

Although S. P. Langley had made the first scientific demonstrations of aeronautical principles in 1896 at Quantico, Va., and the Wrights at Kitty Hawk, N. C., in 1903, had made the first successful flight with a heavier-than-air machine carrying the pilot, and though from time to time several nations, principally European, had made extensive additional experiments, it was not until the early part of 1911 that the first practical naval aircraft operating from and over, and alighting upon the water, was invented. This craft was an invention of Glenn H. Curtiss, an American, and his construction and operation of the first practical hydro-airplane marks the beginning of naval aviation. Prior to this date, both Curtiss and Eugene Ely had made flights in a land plane equipped with the usual landing gear, and further equipped with compressed air pontoons under the plane's surface for purpose of flotation in case of a landing upon the water from the decks of certain U. S. Navy vessels.



NAVAL SEAPLANE NC-1, THE ANCESTOR OF A FAMOUS SERIES

For the purpose of these experiments, the vessels used were equipped with false decks forward. In November, 1910, Ely made the first flight from the deck of a war-ship. This took place at Hampton Roads, Va., when in the face of adverse weather conditions and considerable fog, he flew from the Birmingham over the waters of Hampton Roads and Chesapeake Bay.

As early as 1905, Curtiss had conferred with the Navy Department on the feasibility of successful flying with flying boats. From that date, however, to the latter part of 1917, the flying boat, so far as practical operation goes, was little more than a matter of experiment with converted land planes.

From the above, it will be seen that the interval between the invention of Curtiss in 1911, and the construction of a practical flying boat in 1917, was given over almost entirely to the field of experiment.

It may be worth while to glance at the work along these lines in the intervening years. In 1911, the United States Government organized the first Naval Aviation Section. This consisted of a few naval officers specially detailed for the purpose of observation, training, and experimentation along the lines of aviation in its relation to the Navy. It included Lieut. T. G. Ellyson and Lieut. John Rogers, U. S. N. Ellyson was the first naval aviator to qualify, Rogers the second. Their preliminary flight training was obtained at the flying schools conducted by Curtiss and the Wright Brothers. A short time later Lieut. John H. Towers and Ens. V. D. Herbster, U. S. N., were similarly assigned. In 1912, Naval Constructor H. C. Richardson commenced training, with Lieut. Comdr. H. C. Mustin, Lieut. P. N. L. Bellinger, Lieutenant Chevalier, Lieut. B. L. Smith, U. S. M. C., Lieut. W. Billingsly, and 1st Lieut. A. A. Cunningham, U. S. M. C., qualifying the same year. In 1913, Lieut. M. L. Stolz and Lieut. R. C. Saufley, U. S. N., were added to the ranks of naval aviators. These men, with Civil Engineer J. V. Rockwell, Lieut. K. Whiting, Lieut. C. K. Bronson, and perhaps half a dozen others, were the pioneers in naval aviation.

This list does not include the names of at least two men who started their aviation activities as civilians before the naval aviators mentioned, and who, since the declaration of war, have become U. S. naval aviation officers. Reference is made to Lieut. Comdr. J. Lansing Callan, whose aviation activities started from his association with Mr. Curtiss in the fall of 1911, and whose record covers the whole span of early experiments. Before the United States entered the war, he was chief flight instructor to the Royal Italian Navy, and upon our declaration became commanding officer of the U. S. naval air stations in Italy; and to Lieut. Beckwith Havens, who was also associated with Curtiss in the early days, and who since 1918 has been an officer of the U. S. naval aviation forces.

The first naval aviators and student aviators conducted their flights during the winter months at the Curtiss school in San Diego, Cal. Early in 1912, the first naval aviation camp was established at Annapolis, and here flying operations were now carried on during the summer. In the winter of 1912-13, the second camp was started at Guantanamo, Cuba. In those days, and for some time beyond, aviation camps in their composition and character were essentially different from the naval air stations of today. Then, a few portable canvas tents, a good beach, and a sheltered body of water, usually with the co-operation of a naval vessel specially detailed as an aviation ship, comprised the entire equipment. Two or three planes, with a makeshift machine shop, made up the material, and an instructor, a student or two, and a couple of mechanics, comprised the personnel.

In December, 1913, the Annapolis camp was broken up, and the personnel and equipment transferred to U. S. S. Mississippi, which was stationed off Pensacola, Fla. In January, 1914, a naval air station was erected at the latter place, and this then became the first fixed naval air station in the United States. Lieut. Comdr. H. C. Mustin, the commanding officer of the Mississippi, and one of the earliest naval officers to take up aviation, became the first commanding officer of the Pensacola station. In the summer of 1914, the Government, having sold the U. S. S. Mississippi, the U. S. S. North Carolina became the U. S. Naval Aviation ship.

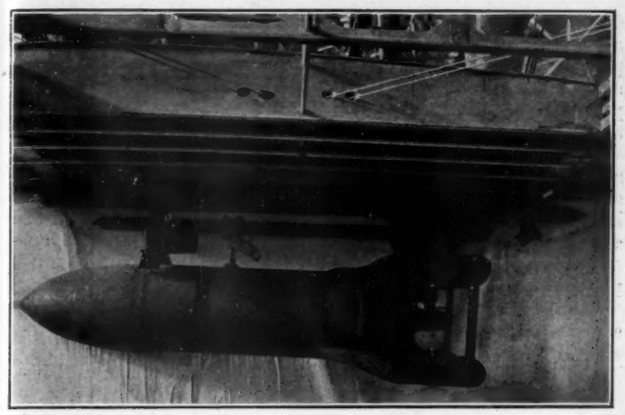
The mention of the Birmingham and the Pennsylvania, from which flights were conducted on the west coast in 1911, the Mississippi and the North Carolina, has a special significance. It is perhaps not generally understood that up to as late as 1917, all plans revolving about the central idea of sea flights as distinct from flights over land inevitably included the use of warships. It was the accepted notion that the usefulness of airplane flights over the water, so far as they related to naval possibilities, was limited to the extent that they could co-operate with, and maintain contact with the units of the fleet. During the active operations by seaplanes in the theatre of war, this original theory has been very largely modified. Motor improvements, amplification of effective operating radius due to increased fuel supply and the satisfactory construction of comparatively sea-worthy hulls, had not a little to do with this

* Prepared by Bureau of Naval Operations, Navy Department.

variation of the initial concept of seaplane usefulness.

A review of the early experiments in the seaplane field would not be complete without mention of the use of the catapults and the single cable as launching apparatus. First, Ellyson at Annapolis from a float, and then Mustin, first from a ship underway, and Bellinger at Pensacola from a barge, operated planes which were projected into the air by compressed air catapults erected on the deck of the North Carolina. Later, others successfully repeated the same experiment. Ellyson, about the same time, made his celebrated flight from a single improvised wire cable running from the shore to the water.

The first Curtiss seaplane was of 100 hp. Later, other types were: two Renault 70 hp. planes; twenty four-cyl. Wright 40 hp., and two six-cyl. Wright 60 hp. planes. These, in addition to a Sturtevant 40 hp. plane, made up the entire equipment with which naval aviation was carried on by naval officers during its formative period. The longest time that



AIRCRAFT BOMB IN ITS CARRIER ON A NAVAL SEAPLANE

one of these planes could remain in the air was slightly over two hours, the average being about one hour and forty-five minutes. They were two-seater, open faced, pusher type, and of frail construction. The pilot and passenger were seated on a sort of open frame work immediately in front of the motor. The tail of the plane was made of light bamboo poles. A crash, however slight, was always accompanied by serious casualties, due not only to the light construction, but also to the fact that motor radiators were placed immediately back of the pilot's head.

In 1913, Billingsly was killed in a crash, and in 1914 and 1915, Murray and Stolz each made their sacrifice to the new science. In 1916, Rockwell and Saufley were killed within three weeks of one another, and in the same year, Bronson was killed by the premature explosion of a bomb.

The first operations at Pensacola were carried on in the E-type of seaplane with pusher propeller, and a few F-type flying boats, but in 1916 these were superseded by the N-type of tractor planes, and from this date on, the percentage of fatalities from seaplane accidents was greatly lessened.

Most of the planes used, it will be observed, up to 1917 were converted land planes, so that to a certain degree the early development of naval aviation was very largely related to, and connected with, the program of military aeronautics. Inspired by our discoveries and demonstrations in hydro-airplane construction and flight, France, always in the van of aeronautic development, as early as 1912 secured a seaplane for the use of its Navy. Immediately thereafter, plans were formulated for the erection of a French aviation section, and before the end of the summer of 1912, she had appropriated ample funds for the new department, had erected a naval aviation centre on her coast-line, and had fitted out and detailed a special war-ship as an Aviation ship. It is probable that the interest of the French Government in the possibilities of naval aviation had been quickened by the purchase of a Curtiss hydro-airplane in 1912 by the celebrated French naval aviator Paulhan.

The United States made its first special appropriation for naval aviation in 1914 in the amount of $10,000. This was for the fiscal year ending June 30, 1914. For the following year, a similar sum $10,000 was appropriated. For the year ending June 30, 1916, $1,000,000 was appropriated. For the year ending June 30, 1917, $3,500,000 was appropriated. June, 1918, $64,133,000 was appropriated; and in the year ending June 30, 1919, the sum of $220,383,119 was appropriated by this Government for naval aviation of this which $97,000,000 was withdrawn by a Congressional Repeal Act.

We now come to a consideration of the growth of naval aviation since the declaration, in April, 1917, by this Government that a state of war existed with Germany. At that

37 MM. ANTI-SUBMARINE GUN MOUNTED ON A NAVAL SEAPLANE

time such planes as were in use were either converted land planes or somewhat antiquated flying boats of the original Curtiss design, capable only of short flights, operating either from a shore station or from an immediately accessible naval vessel. These planes were of insufficient structural strength to successfully stand more than very moderate seas.

In the latter part of 1917, improvements in hull design and construction had so far progressed that an effective, practical flying boat was turned out for the use of the United States Navy. In the spring of 1917, and through the following months, however, the Navy Department was not idle, and was not indifferent to the necessities of naval aviation. The construction of a chain of naval air stations along the Atlantic seaboard of the United States was begun. Additional schools for the instruction of pilots, ground officers, and specially trained enlisted personnel were started. Accommodations at the existing air stations were amplified. A special board of naval officers was sent to France to study the situation, and upon its return to this country, a type of seaplane was decided upon, and from that moment the plans of the Department gained great headway. At this point, it is interesting to note that the type of seaplane decided upon shortly after we entered the war has been consistently adhered to throughout all subsequent operations. This decision had one immediately important result, namely: quantity production of naval aircraft, and smoothing the way to an integrity of organization in the administrative processes of the new work.

Operations in the Great War

When the United States entered the war on April 6th, 1917, only one naval air station, (Pensacola, Fla.) was in operation. The total aviation personnel consisted of 38 officers and 163 men. With this small personnel the operations were neces-

sarily very limited, and consisted largely in training and experimental work with various types of seaplanes. Lighter-than-air work was even more limited than heavier-than-air, as the Navy owned only two kite balloons and one airship. As soon as the United States entered the war, extensive plans were made for the creation of aviation activities both abroad and at home. On Nov. 11, 1918, aviation stations were in commission as follows:

UNITED STATES, CANADA AND PORTUGAL

Anacostia, D. C.	Key West, Fla.
Bay Shore, L. I.	Miami, Fla.
Brunswick, Ga.	Montauk, L. I.
Cape May, N. J.	Morehead City, N. C.
Chatham, Mass.	North Sydney, N. S.
Coco Solo, C. Z.	Pensacola, Fla.
Halifax, N. S.	Ponta Delgada, Azores
Hampton Roads, Va.	Rockaway, L. I.
San Diego, Calif.	

FRANCE

Arcachon	Brest
Dunkerque	Fromentine
Guipavas (Brest)	Gujon
Ile Tudy	L'Aber Vrach
Le Croisic	La Pallice
La Trinité	Moutchic
Paimboeuf	Pauillac
St. Inglevert	St. Trojan
Tréguier	

In addition to the above, an extensive activity for bombing operations was created in Northern Flanders, called the Northern Bombing Group.

GREAT BRITAIN

Berehaven	Eastleigh
Lough Foyle	Queenstown
Wexford	Whiddy Island
Killingholme	

ITALY

Porto Corsini	Lake Bolsena

At the time of the Armistice, the following personnel was assigned to naval aviation:

Naval aviation officers	2835	
Marine officers	282	
Naval enlisted personnel	43452	
Marine enlisted personnel	2180	
Grand total	48749	
Total officers serving abroad Nov. 11, 1918		1138
Total men serving abroad Nov. 11, 1918		18167
Grand total—Officers and men		19305

Before dealing with the record of substantive achievements by naval aviation during the course of the war, it is perhaps germane to the enquiry to describe the purpose of seaplane operations, the mode of operation, and to point out the reasons which led to the establishment of stations on this side of the Atlantic. The reason for the seaplane in actual war operations can be briefly given in the word "submarine." In this one word was comprehended the maximum menace of the Teutonic powers. Surface craft operations were an ineffectual answer to the problem. The amount of destructive potentiality of a single submarine is perhaps not generally understood. From figures compiled by Vice-Admiral Sims, in charge of Naval Overseas Forces, during the war, it is learned that every German submarine operating accounted for approximately $30,000,000 worth of allied shipping. Knowing the number of submarines operating, and the total tonnage destroyed, it was a comparatively simple operation to allocate to each enemy submarine its share of the destruction.

There were four modes of operating as follows:

Routine patrol.
Escort patrol to convoys.
Emergency patrol.
Special bombing patrols over submarine bases.

Large seaplanes with an extensive cruising area were generally used for routine patrol. These planes carried either one or two bombs, weighing either 230 or 500 lb. each, and were also provided with machine gun equipment. As a rule, smaller type aircraft were used for convoy escort. These, too, carried bombs and machine guns. A specially designated seaplane always kept in readiness was maintained at all times at the stations for emergency patrols. For bombing operations against submarine bases, different types of planes were used, in some cases, especially in the so-called Northern Bombing Group, land planes having been assigned to this particular work.

The method of operations of the patrols was as follows: Each naval air station had a certain defined zone of operation, and it was the duty of the officers in charge to so plot out their patrols that they would most effectually and thoroughly cover the sea area within their jurisdiction. This applies to the routine patrols. For the purpose of convoy escort, the course to be followed by the seaplanes of necessity was limited to the course traversed by the vessels and varied with the particular situation. Emergency patrol may be defined as one sent out to a precise location at sea in answer to advices of enemy activities presently existing at that point. A patrol against submarine bases was one despatched from a naval air station, either over land or over the sea, to a neighboring port at which submarine activities were concentrated. A routine patrol normally lasted an average of three hours, although in some instances, there are records of routine patrols by seaplanes covering a period of five hours in duration, and a mileage of over three hundred nautical miles.

The primary purpose of these routine patrols was one of search for enemy surface or under-surface craft. Their mission was wholly offensive in character, and required them to bomb all enemy craft encountered. The primary purpose of a convoy escort patrol was to cooperate with the destroyers and accompanying naval vessels in protecting troop and supply ships both in and out of allied ports.

These seaplane escorts to convoys were planned with reference to the speed of the convoy, and generally speaking, operated in a succession of oval loops covering the convoyed train. By the use of several planes following one another at stated intervals and keeping relatively the same distance from each other, the adjacent sea areas were thoroughly and continuously kept under observation. Operations by naval aircraft against submarine bases were carried out as follows: They were usually despatched by the shortest route possible to the objective, released their bombs, and as soon as possible returned to their home station. These operations were carried on in the main at night time.

The station abroad with the exception of schools and bases at Moutchic and Pauillac, France; Eastleigh, England; Queenstown, Ireland; and Lake Bolsena, Italy, were for operations against the enemy. In general, they carried out anti-submarine patrols and convoy operations.

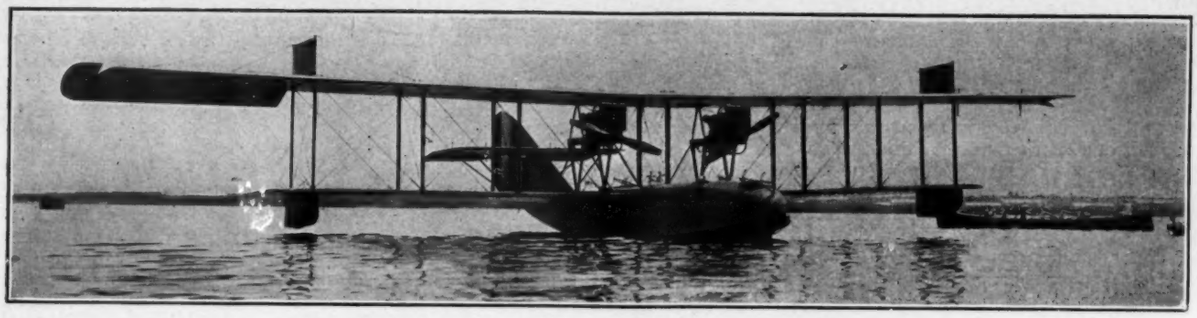
The first American patrol in France was made at Le Croisic on November 18, 1917, and the last patrol was made at Brest on Dec. 13, 1918, upon the occasion of the President's arrival. 4314 patrols were carried out by American stations in France covering a distance of 416,767 naut. mi.

The major operations for U. S. naval aviation were of necessity conducted in the immediate theatre of war. For the conduct of these operations, nine U. S. naval air stations operated in France, located at Treguier, L'Aber Vrach, Brest, Ile Tudy, Le Croisic, Fromentine, St. Trojan, and Arcachon, Dunkerque, and an airship station at Paimboeuf.

Treguier and Arcachon did not begin operations until shortly before the Armistice was signed, and the effective period of operations of the other stations did not average six months; but from April to November, 1918, according to French reports, the members of the six active U. S. naval air stations in France sighted twenty-seven submarines, attacked twenty-five, damaged twelve, and probably sank four. During the period of their operations, the U. S. naval air stations of the French coastal unit also escorted 477 convoys, besides destroying mines laid by the enemy. It is stated as a fact that no convoy operating within the area of the U. S. naval air stations on the French coast, and under the United States aerial escort, was successfully attacked by hostile submarines.

The following official tribute by the French government to the work of the U. S. naval air stations in France summarizes in a few words the broad range and character and result of their operations:

"The entrance into the service of the Franco-American patrols of the Loire, acting in absolute cooperation with the



NAVAL SEAPLANE F-5-L, FITTED WITH TWO LIBERTY ENGINES

re-organized and increased surface patrols, broke the blockade by enemy submarines of the French coast, and enabled the authorities to receive accurate information regarding the location of enemy submarines, besides compelling them to cruise in regions where navigation was not very extensive."

In fact, it can be stated that during the last ten months of the war only three ships were torpedoed or destroyed by cannon in our patrol area: that is to say, between the points Penmarsh and Ile D'Yeu; whereas in the same region we lost on the average of one ship a day, when, in May, 1918, the aerial service of the Loire was created.

The U. S. naval aviation service controlled a large part of this success, which may be qualified as brilliant since it is figured that the efficacy of the submarine war was reduced ninety-nine per cent.

It may be interesting to note the number of emergency or S.O.S. calls received at and responded to by U. S. naval air stations of the French coastal unit during the time of their operation. At Ile Tudy, there were forty-two of these emergency patrols despatched; at St. Trojan there were fifty-seven; at Le Croisic twenty-four; at Fromentine eight; L'Aber Vrach one; a total of one hundred thirty-two emergency patrols.

The Northern Bombing Group had as its mission the attack of German submarine bases in Belgium. For this purpose the group was divided into day and night bombing squadrons, the day bombing being carried out by the Marine Corps and the night bombing by Navy personnel. This group did not get into active operation until just before the Armistice was signed. The first night bombing operation was carried out over Ostend in August, 1918, and the first operation of the day wing took place on October 14, 1918. Naval aviators from this unit were, however, assigned to British squadrons pending establishment and assisted in many British bombing missions.

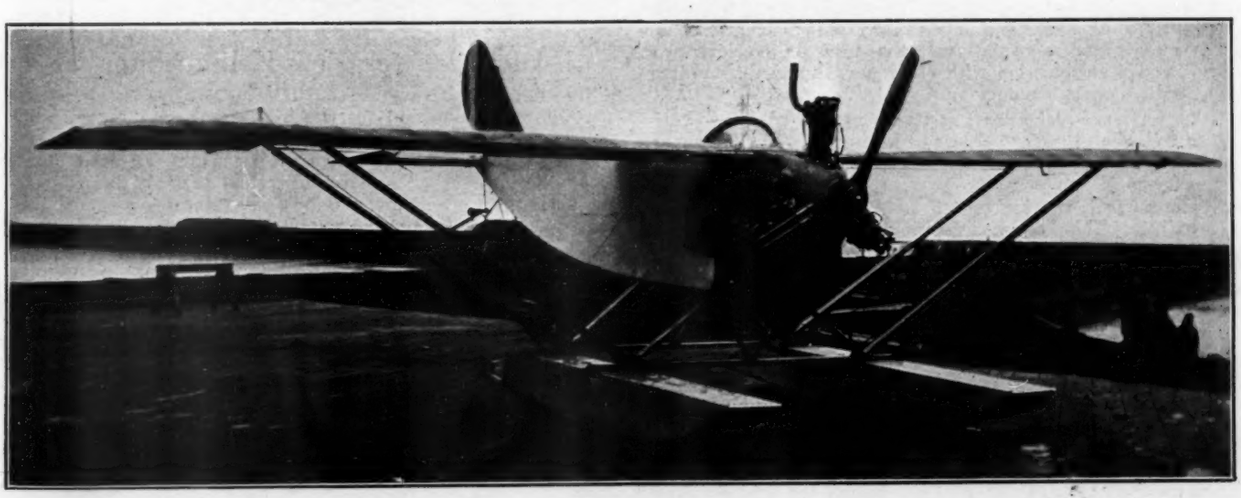
Operations in Great Britain were carried on by seven stations; five being located in Ireland and two in England, the patrol station in England being placed in commission on June 30, 1918, and from that date until the signing of the Armistice convoyed 6,000 allied vessels and covered approximately 60,000 mi. upon 233 patrols.

Operations in Italy were confined to the training of pilots and the operation of one combatant station. Operations at Porto Corsini were begun by raid over Pola which took place on Aug. 21, 1918. From then until the signing of the Armistiec, regular bombing raids and war patrols were carried out.

U. S. naval aviation abroad flew a total of 791,398 naut. mi. on patrol.

The principal duty of coastal air stations and detachments in the United States during the war was the training of officers and men for actual combative work. At the same time, it was necessary to carry out regular anti-submarine patrols and convoy operations. Before a pilot was ready for work on an operating station he was sent through three separate schools. For a period of three months student officers were first trained at ground schools in the theoretical part of the subjects pertaining to naval aviation. They were then sent to elementary training stations where they received flight instruction along with a review of the various subjects they had taken up at ground school. The elementary stations, although essentially for training, carried out regular war patrols. Upon the completion of elementary instruction, students were sent to the advanced training station at Pensacola, where they were given a course in practical bombing, navigation, gunnery, radio, etc. Upon the successful completion of this course they were commissioned as Ensigns in the Naval Reserve Force and designated as "Naval Aviators." At the conclusion of the war approximately forty qualified aviators were being turned out from Pensacola each week.

Lighter-than-air students were given elementary training in free and kite balloons at Akron, Ohio, and later sent to Rockaway, Cape May or Hampton Roads for airship work before being qualified as "Naval Aviators."



THE SMALLEST NAVAL SEAPLANE: THE LOENING "KITTEN"

In addition to other operations, a number of ground officers were trained at the various stations for specific duties such as executive, gunnery, navigation officers, etc.

Without going too much into detail on the subject of seaplane operations against the enemy on this side of the Atlantic, it may be of interest to recall that enemy submarines were operating off the Atlantic seaboard through several months of the year 1918, and that in addition to this, the United States despatched convoys from Atlantic ports carrying over two million soldiers abroad from the declaration of hostilities until the signing of the Armistice. It was obviously a matter of first importance that these convoys, as well as the innumerable supply ships, should be safely escorted from their ports of embarkation. It can be pointed out as a matter of pardonable pride that the protection afforded by the Navy Department in the shipment of these troops and munitions, both by the employment of surface and Naval aircraft, was so thorough and effective that during the entire course of the war, not a single convoy or Naval vessel, nor the life of a single American soldier or sailor was lost within the sea area under the jurisdiction of U. S. naval air stations on this side of the Atlantic.

Demobilization was started shortly after the Armistice was signed. By Act of Congress, naval aviation was limited to six heavier-than-air stations within the continental limits of the United States. It became necessary, therefore, to dismantle a number of stations, but the following were retained as permanent establishments:

Chatham, Mass.	Lighter-than-Air
Rockaway, L. I., N. Y.	Heavier-than-Air and Lighter-than-Air
Cape May, N. J.	Heavier-than-Air and Lighter-than-Air
Anacostia, D. C.	Experimental
Hampton Roads, Va.	Heavier-than-Air and Lighter-than-Air
Key West, Fla.	Heavier-than-Air and Lighter-than-Air
Pensacola, Fla.	Heavier-than-Air and Lighter-than-Air School
San Diego, Calif.	Heavier-than-Air and Lighter-than-Air School
Coco Solo, C. Z.	Heavier-than-Air and Lighter-than-Air
Quantico, Va.	Heavier-than-Air Marines
Paris Island, S. C.	Heavier-than-Air Marines
Great Lakes, Ill.	Mechanics' School

At all fleet bases both in the United States and foreign possessions, it is the desire to establish aviation facilities.

The peace time operation of shore stations is as nearly as possible similar to that carried on during war. A regular schedule is laid down well ahead of time in order that the personnel may be able to thoroughly carry out its duties under any circumstances and in any emergency. Pilots are kept in constant training in various aviation subjects such as bombing, gunnery, navigation and radio. Competitive target practices are carried out periodically. Practice patrols are made frequently, both alone and in company with submarines and surface craft and air stations take part in various war maneuvers in conjunction with other naval units under direction of the district commandants.

Developments as Result of War

The following developments and achievements mark the results of the U. S. naval aviation activities during the war:

The large NC type flying boat, capable of carrying very heavy armament, was successfully developed for long distance war patrols. This boat was not finished in time to engage in active combatant operations. In May, 1919, Comdr. J. H. Towers was given command of a group of three boats of the NC type for the purpose of making a flight across the Atlantic. Elaborate arrangements were completed in order to insure, insofar as practicable, the success of the expedition and to obtain the fullest information and most complete data regarding the venture. The NC-4, starting with a weight of 28,600 lb., under the command of Lieut. Comdr. A. C. Read, made the trip successfully, and by his splendid achievement added a lasting glory to the record of the American Navy. In this, the first successful trans-Atlantic flight, 4513 mi. were covered in 53 hr. and 31 min. of flying. The longest leg of this flight, from Trepassey to the Azores, 1380 mi., was covered in 15 hr. and 18 min. This splendid feat proved that the NC type of seaplane was eminently fitted for the purpose for which it was designed.

On Apr. 25, 1919, a twin-motored flying boat of the F-5 type, fitted with two direct drive high compression Liberty engines, made a non-stop flight of 20 hr and 10 min., during which time a distance of approximately 1250 nautical miles was covered. This boat carried a crew of four and the total weight was approximately 16,200 lb.

Considerable progress was made in the development of the non-rigid airship. The C-5, commanded by Lieut. Comdr. Coil, established a world's record for a non-stop flight for airships of the non-rigid class in May, 1919, when a flight was made from Montauk, L. I., to St. Johns, Newfoundland, a distance of 1050 naut. mi. in 25 hr. 50 min. flying time. It is believed probable that but for the unpreventable loss of this ship in a storm in Newfoundland, this vessel would have successfully completed the first direct trans-Atlantic voyage in the air.

Radio transmission on aircraft was greatly improved during the period of hostilities. On the trans-Atlantic flight two-way communication was maintained with a shore station over a distance of 700 mi. One seaplane was heard at the Bar Harbor, Me., receiving station from a distance of 1,400 mi.

As a further result of war activities, naval aviation is now supplied with a Reserve Flying Corps comprising approximately 4000 officers and 20,000 men, of which 2500 of the officers are qualified naval aviators, and 1500 officers are trained aviation technicists and administratives. The enlisted personnel of the Reserve Corps has been trained for aviation duties, and, as a class, are believed to be as expert aircraft mechanics as the present state of the science can develop.

Relieved of the pressure of war, it has been possible, since the signing of the Armistice, to give further thought to the broad development of naval aviation as an auxiliary to fleet operation. Mobility which will permit distant oversea operations in any quarter of the globe is desired. With this object in view, a fleet air detachment was assigned to the U. S. Atlantic fleet during the past winter for maneuvers. This detachment consisted of six twin-motored flying boats, three single-seater scout airplanes, and a division of kite balloons, with proper personnel to man these craft, and was assigned the U. S. S. Shawmut as mother ship.

The detachment served with considerable success. The flying boats were used for search problems, bombing practice and spotting. Spotting for the fleet was also done by land type machines with marked success. Kite balloons were used from battleships. Certain of the latter have also been supplied with flying machines mounted upon their turrets from which they are launched.

Plane carriers such as are in use with the British Grand Fleet have not yet been supplied, but it is believed that naval aviation has taken advantage of its opportunity to establish itself as a permanent arm of the Navy and will soon demonstrate to the older branches of the service its future possibilities as an indispensable part of the service.

Exploration for New Helium Supplies

The Army and Navy Helium Board recently considered the question of exploration for new sources of supply of helium for the airships of the two departments. The board recommended that this question of exploration and all other questions relating thereto be placed in the hands of the Department of the Interior. Secretary Daniels approved the recommendation, and an allotment of $25,000 each from the War Department and the Navy Department has been allocated for the purpose of carrying out a research and conservation program relative to helium. The House Committee on Public Lands on Oct. 21 reported the bill S.2775, to promote the mining of coal, phosphate, oil, gas and sodium on the public domain. It is stated that "Upon the urgent request of the Secretary of War and the Secretary of the Navy, your committee added in section 1 of the House draft a provision reserving to the United States all deposits of helium in the public land, and in section 38 of the committee draft provided further that the United States Government shall have the preferential right to obtain, extract and remove helium from all lands and all deposits leased under the act under such rules and regulations as shall be prescribed by the Secretary of the Interior."

Effect of Envelope Pressure on Airships

By R. H. Upson

Chief Aeronautical Engineer, The Goodyear Tire and Rubber Co.

The effect of envelope pressures in non-rigid airships pertains to a subject which is pretty closely connected with airship design in general, but there are many aspects of the question which should be carefully considered by any one having to do with airship operation.

Nature and Purpose of Gas Pressure

The reason for maintaining a pressure of gas is of course to maintain the proper rigidity for what would otherwise be a purely non-rigid envelope. In the usual form of semi-rigid airship a slight pressure is maintained to hold the various structural members in their proper positions. In a full rigid design there is usually no pressure at the bottom level of the gas. In any type of airship, however, there is always pressure at the top, due to the head of gas at that point. According to American practice, when we speak of envelope pressure, we mean the pressure of gas at the bottom of the envelope. The minimum pressure which may be used in any particular case is always governed by one or more of the following purposes:

(1) To prevent the nose from caving in.
(2) To prevent the bag from buckling.
(3) To keep bad wrinkles out of the fabric.

In all airships hitherto in use in this country item (1) has been the critical one for flight under full power, while (3) has always been the critical item for static conditions, such as in the hangar.

The principal danger from too low a pressure is in case of broken battens piercing the gas bag. That this is a real danger cannot be doubted, but it hardly applies except at full power, and even then there are several cases of the nose having caved in with no serious consequences. In flight then the pressure should be kept high enough to prevent the nose from caving in, but with as small a margin above this point as possible. For any given speed the average pressure which must be sought depends to some extent on the stability of the ship and the atmosphere; in other words, on the pilot's judgment as to how much allowance he need carry above the theoretical lower limit. Aside from this the operating pressure may be cut down for lower speeds about in proportion to the engine r.p.m. While standing in the hangar the pressure may and should be kept very much lower than is necessary in flight. The only object here is to keep *bad* wrinkles out, and the pressure necessary to accomplish this is surprisingly small, usually in the neighborhood of ½ in. or 10 mm.

Effect of High Pressure on Envelope Cloth

Whether flying or in the hangar, but especially in the hangar, it is important to keep the pressure as low as possible. It seems a popular impression has been gathered from pneumatic tire experience that the most important thing in a balloon is to keep the pressure high enough. This is further influenced by the idea that there is a large factor of safety in the balloon and that the purpose of the safety valve is to keep the pressure automatically within safe limits. As a matter of safety from bursting this is true, but there are other very serious effects of high pressure which must be taken into account.

First consider the effect of undue pressure on the cloth or strength element of the fabric. It puts upon it an extra tension which above a certain point is very bad. A fabric which has been continuously strained will not hold as much as one which receives only momentary stresses. For instance, if the factor of fatigue of a fabric is 2.8, this means that a given kind of fabric will support momentarily about 2.8 times as much stress as it will continuously. If necessary, the safety valves may be set up to a pressure which will leave a total factor of safety of only 4 without any particular danger, *providing* the automatic operation of the valve is only relied on for an emergency, in which case the maximum pressure will be of very short duration. For any condition lasting longer than say 5 min., it is aimed to have the total factor of safety between 6 and 8.

Effect on Rubber

There is another factor, however, which makes it desirable to carry even lower pressure whenever possible. This is the fatigue effect on the rubber of the gas film. The following interesting experiments may be made by any one who will go to the trouble. Take two large rubber bands and hang them on nails out in the sunlight, put a slight tension on one of them, enough to stretch it a few per cent; then notice the condition of the bands after only a few days of exposure. If they were in the same condition to start with, the one which had been stretched will be found to have aged out of all proportion to the other.

An envelope recently got in a leaky condition and was found to have been stretched, or strained very severely in all directions. A microscopic examination of the gas film showed that in the strained portion there were a number of small holes, evidently caused by fatigue of the rubber. This is a condition that is not much affected by temporary strains as would result on a bumpy day during flight, but is the effect of continued straining undoubtedly from various causes no one of which could be held entirely responsible.

The only safe rule to go by is to always maintain as low a pressure as possible. The minimum pressures permissible for different speeds are given in the instruction books for the various ships.

Errors of Measurement

In the case of some ships, noticeably those of Class "C," trouble has been reported from caving in at pressures greatly in excess of what has actually been tested practice at Akron. So far as we can see there are only three possible causes for this:

(1) Inaccurate observation.
(2) Improper adjustment of the manometers.
(3) False reading of the manometers, due to dynamic effects.

The first item above is simply a matter of careful attention, allowing for the bumps and for the inclination of the ship if extreme. As to item (2) the manometers should be checked every day to see that they read correctly with the manometer tube full of hydrogen. They should be adjusted to compensate for the head of gas between the car and the bag. In the Class "C" ships this amounts to setting the liquid to start with at 4 mm or .15 in. above the zero mark.

Item (3) is one which is more difficult to check and is also subject to change. For instance, if a larger wind shield or some other obstruction is placed in front of the pilot's cockpit it usually causes a suction on the free end of the manometer, thus producing a reading which is too high; sometimes the reverse takes place and the manometer may read, for instance, 25 mm. when the real pressure in the bag is 30 or 40 mm. If anything like this is suspected or in any case where changes are made in the equipment surrounding the cockpit, careful tests should be made to determine whether the free end of the manometer is at atmospheric pressure. This may be done as follows:

(1) During stable flight see that all valves and dampers are tight. Throttle the engine down quickly from full power, keeping the ship at the same altitude by use of the statoscope. If the pressure goes through any marked change in this process it is an indication that the reading has been effected by conditions in the cockpit.

(2) Mount a propeller from another car directly in front of the car being tested, while in the hangar, and repeat the above process.

(3) Attach a light rubber tube to the free end of the manometer in question and try leading it to different positions in the car.

(4) If it is a stubborn case, call in an aerodynamic expert for advice.

Factors Affecting Gas Purity

Contrary to general opinion, pressure has very little effect in preventing the inward diffusion of air, providing there is no actual suction at the bottom of the bag. To assure maximum gas purity air should be kept out of the ballonets as far as possible. To do this while at the same time keeping the pressure down, without undue wastage of gas, requires rather careful management. The easiest way in the hangar is to have a steel gas holder properly counter-balanced to maintain the proper pressure. Then the balloon can be left permanently connected while in the hangar.

An incidental source of trouble with ballonets should be here noted. Several balloons have been found with sand and all sorts of rubbish in the ballonets, together with the inevitable holes. An ostrich can get away with this but we haven't been able to make balloons yet that can. It is a good idea to be *particularly* careful about running the propellers in a sandy locality. The air valves should be taken out once in a while and the ballonets should be inspected inside.

The Watkins Foulnot Parachute

By Wm. F. Watkins

The Watkins Foulnot parachute constitutes a very valuable safety device for the airplane. It requires only three-fourths of one second for quick opening and has a rate of descent of 14 ft. per sec., as demonstrated at Atlantic City in May, 1919.

The specification and complete detailed description are as follows: Diameter, 24½ ft., shroud lines 26 ft., breaking strength each line 250 lb. Total strength of shroud lines 6500 lb.

The parachute is made in four grades of material.

Grade	Material	Weight
1	Japanese silk	18½ lb.
2	Balloon silk	33 lb.
3	Indian Head linen	..
4	Cotton	29 lb.

The first item to be considered is the strength embodied in the construction of the parachute.

The shroud lines form the base of the entire structure of the parachute, much in the same way as the ribs are the base of the structure of an umbrella. Thirteen lines, 90 ft. long, are looped in the center and served into an eye on a thimble, thus leaving twenty-six dependent ends or lines, approximately 45 ft. in length. The line employed is made of pure flax that will withstand a breaking strain of 250 lb. At the point of the outside edge of the silk cover a line is laid at right angles to the shroud lines and lashed to the individual lines to take the radial stress off of the fabric.

The fabric is laid on the structure of the shroud lines, the lines being faced in, in the same manner as employed on sails or tents. This is to present as nearly a smooth surface as possible, both inside and out. This fabric is composed of the best grade of Japanese silk, to secure the greatest strength and least weight, and at the same time insure it being packed into the smallest possible space.

Referring to the accompanying sketches, Fig. 1 illustrates the bottom view of parachute in the pack. The container itself is made of waterproof material, the top being a single, circular piece, 19 in. in diameter. The sides and bottom are composed of eight segments, bellows and orange peel, constructed as shown in Fig. 2.

Fig. 3 illustrates the manner by which the enclosed parachute is secured in the pack, and the complete and simultaneous opening is insured. The loops on the ends of segments are tied with a cord of only sufficient strength to insure that the pack will not be torn open by the wind. Four cords, much stronger than the stay cord, are looped around the stay and lashed to the life line extending to the wearer's harness, with a slight amount of slack between the lash and the packed parachute. Thus, when a strain is placed on the life line by the jumper leaping overboard, the first strain falls on the light stay cord, breaking it at four places, which insures the complete opening of the pack, the short lengths not offering enough resistance to hold two segments together or being long enough to tangle.

Fig. 4 illustrates the action of the parachute at the instant of leaving the pack, just before the break cord is severed, and further shows the manner in which two hoops are employed to prevent fouling.

By employing two hoops of the same size, one in the top of the parachute and one as near the ends of the shroud lines as possible, a circular flue is formed up through the surrounding fabric. The rush of air up under the fabric causes it to open instantly. A small opening is left at the top of the parachute which serves to secure the draft of air up through the so-called flue; but as it has other purposes it will be dealt with more extensively later.

Referring to Fig. 5, a better understanding may be obtained of the action of the parachute as it leaves the pack. This view is looking upward at the same instant as illustrated in Fig. 4. It will be noted that in placing the parachute in the pack, it is folded so that the folds of the fabric open outward, which in the case of old types of parachutes was considered sufficient to secure the opening of the parachute within a reasonable time. No doubt this feature is of some importance in its use on the Watkins Foulnot parachute; but the real means of securing the quick opening feature is the forming of the draft flue up through the center of the down-dropping parachute which causes it to open in three-fourths of a second.

The open parachute is illustrated in Fig. 6. The Watkins Foulnot parachute has the same shape as the mushroom type umbrella, 24 ft. in diameter. It has an air resistance that allows a body weighting 165 lb. to descend at the rate of 14 ft. per sec., or the equivalent of a 4 ft. free jump.

It often happens that after the descent has been made, the collapsing parachute will become a tangle of lines and fabric, the fabric turning wrong side out and blowing through the shroud lines.

Fig. 7 illustrates a figure eight link that is inserted in the shroud line close to the bottom hoop as a means of detaching the lines easily to effect the untangling. This link is composed of brass, and it will withstand the breaking strain of the shroud line before it will bend open, namely, 250 lb. However, it is an easy matter to spring the link sidewise to a sufficient degree to allow the shroud to be slipped out, untangled and replaced and the link closed again, without impairing its original strength. The opening and closing of the link can be effected with a medium-sized pair of pliers.

Fig. 8 illustrates the manner in which the shroud lines are laid in the pack to prevent fouling as they are pulled out.

Fig. 9 illustrates the canvas harness worn by the jumper and furnished with the parachute.

It is made of the strongest material and will withstand several times the strain it is possible to place on it by jumping from the fastest moving airplane. It is a corset-like jacket, which laces in front and is provided with shoulder and leg loops so designed that the strain is evenly distributed to the body of the jumper. This removes the possibility of stopping the blood circulation and so causing the pilot to land with benumbed feet or arms.

Fig. 12 depicts the quick release clasp by which the jumper's harness is attached to the life line.

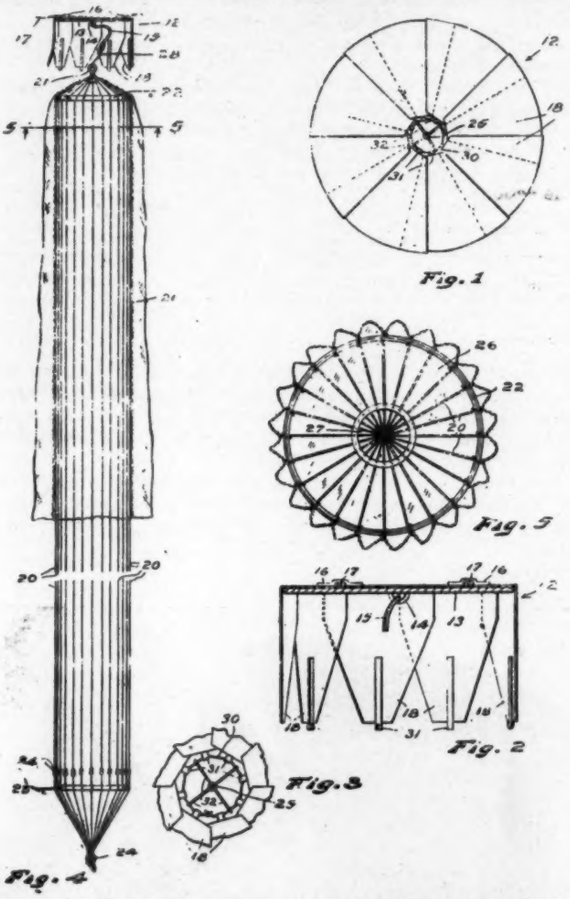
The end of the life line is provided with a link that slips over the beckett of the hinged clasp much the same as the hinged hasp used on barn doors. The clasp is locked down by a turn button that can only be turned by hand. It enables the jumper instantly to release himself from the parachute when the landing is made, or to leave the plane when landed without removing the harness if the flight is to be resumed after a stop.

As is often the case, it is desirable to have some means of guiding the descent, either out from under a burning plane or airship or away from trees or buildings when nearing the ground.

Figs. 10 and 11 show two views of the guiding wings or sails with which the harness of the Watkins Foulnot parachute is equipped. When not in use, the elastic, as indicated by No. 48 in Fig. 10, holds the wings into the sides, and when needed can be extended and the descent guided by turning the wing in the direction in which it is desired to go. With these wings it is possible to control the descent approximately 300 ft. in each 1000 ft. of descent.

Tests made with a sand bag weighing 250 lb. demonstrated the fact that with a closed top parachute, when dropped from a rapidly moving plane, the opening lash was sufficient to snap the top out of the parachute. With a small opening in the top, which let a part of the air pressure escape, this did not occur.

Subsequent tests and demonstration, where the ground elevation was high and humidity correspondingly low, showed that the opening lash was so large that the jumper experienced quite a jar with the opening of the parachute when dropping under favorable conditions.

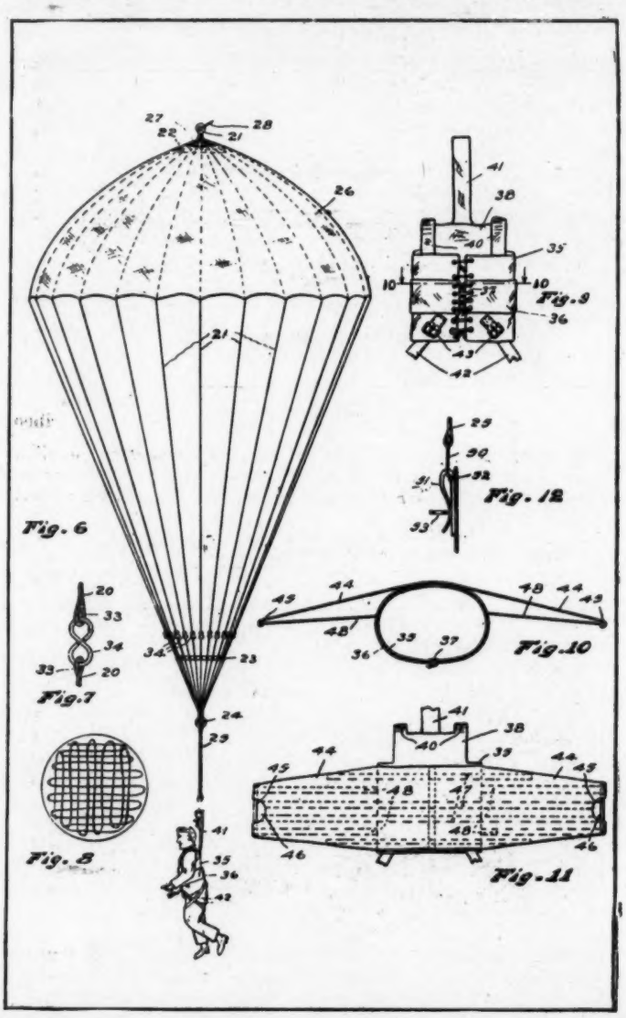


These objectionable features have been completely overcome by the introduction of a larger opening in the top of the parachute which can be completely closed at will, as when nearing the ground, and also the introduction of a shock absorber in the life line, either of which is sufficient to handle the situation, but as both are included they render safety doubly sure. A detailed description of each follows.

The silk fabric is loosened in the top of the parachute and provided with a double-action puckering string such as used to close the top of a laundry bag. Four elastic loops extend over the mouth of the opening, to hold it open until the puckering string is pulled. Thus a 14-in. opening is left in the top of the parachute, allowing enough air pressure to escape so that the sudden jar of the parachute opening is eliminated as is the lash on the fabric. When nearing the ground, the jumper has only to pull the puckering string and thereby completely close the opening to slacken the speed of descent and make an easy landing.

The shock absorber is composed of four strands of airplane landing gear elastic. A slack loop is thrown in the life line and the elastic is bridged across the loop. Thus when the parachute opens the jar is taken on the elastic, which, giving in both directions, relieves the jumper of the jar. Should such a thing occur as the breaking of the elastic, the strain would then fall on the life line; but in any event the jar would be taken up in breaking of the elastic. It is hardly possible that the elastic would break, as it takes the combined strength of four men to get any appreciable amount of stretch in the elastic.

Another feature of the Watkins Foulnot parachute is the life line. This is composed of the ends of the twenty-six shroud lines, cabled and served with a mousing of light flax whale line. With the exception of the figure eight links, the shroud lines are continuous from the eye of the life line up over the top of the parachute and down on the other side to the eye of the life line again. Thus the use of a number of eyes and thimbles is eliminated and the maximum strength of the parachute



insured. The life line has therefore a strength of 6500 lb. on the shroud lines alone, which is greatly augmented by the mousing.

The parachute here illustrated and described is designed to be fastened on the bottom of the fuselage of an airplane, balloon or airship car, and with this type the cover or container stays on the craft.

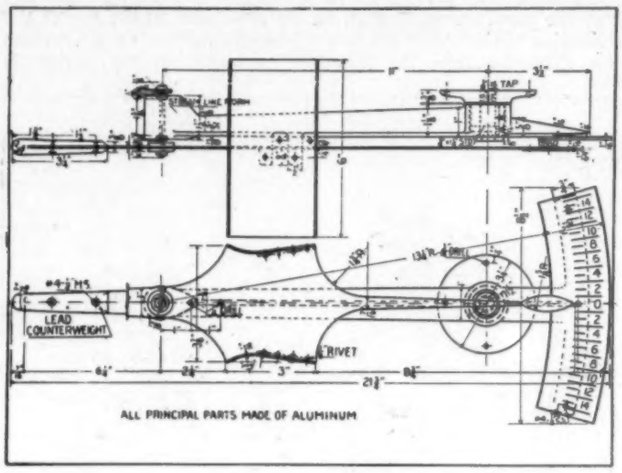
This parachute is also constructed in the Ball and Pack type, which is simply reversing the parachute in the pack, and by fastening the break rope to any part of the craft, the jumper has but to pick up the pack, which is taken in the car with him, and leap overboard, letting loose of the pack as he clears the side. Thus the break rope at the top of the parachute holds it until the lines are fully extended and the light break string severed, while the pack container descends with the jumper. The construction of the parachutes in both types is identical, the difference being the way in which the parachute is released.

Development of an Aircraft Incidence Meter*

By A. D. Zahm, Ph.D.

Navy Department, Bureau of Construction and Repair

To enable the air pilot to read at a glance the direction of flow of the air past his airship or airplane, a balanced weather-vane, indicating promptly small changes of incidence, has been developed and tried under regular working conditions.



Plan for aircraft incidence meter.

The scale drawings and test of the device herein described were made respectively by L. H. Crook and S. S. Rathbun, members of the aeronautics staff at the Washington Navy Yard.

* Reprint from the Franklin Journal.

Model.—Figs. 1 and 2 give the general appearance and dimensions of this instrument. It consists of a two-blade weathervane supported from a horizontal pivot at the end of a bracket arm protruding forward from an airplane strut and adjustable in pitch by means of a clamping nut at its base. The vane has a forward counter-weight to insure static balance and a pointer playing on a graduated arc of 14 in. radius, indicating even degrees and readable to fractions of a degree from the pilot's seat. The blades have the sectional shape of an Eiffel Wing No. 5, which at zero incidence possesses very slight drag and a large increase of lift with slight increase of incidence.

Wind Tunnel Test.—When the instrument was given its preliminary test in the 8 x 8 ft. tunnel, its pointer remained steadily fixed in the wind direction until forcibly displaced. It then promptly returned to zero incidence without lag or indication of friction.

Observations with C. & R. Incidence Meter in Flight

Speed of Flight in Knots	55	65	75
Normal variation	±0.6°	±0.4°	±0.4°
Precision of reading possible	±0.3°	±0.2°	±0.2°
Occasional variation	±2.°	±1.°	±1.°

Test in Flight.—The instrument was finally mounted midway between planes on the nearest right-hand strut of Flying Boat HS-2 No. 1840, and carried through very still air at three different fixed speeds. The preceding table indicates its behavior under these circumstances.

Conclusion.—If this instrument is to be put into use, it may be lightened somewhat and provided with a strap to lash its flange to the airplane strut. So finished, it would weigh about 1.5 lb.

The Blackburn "Kangaroo" Entered in the London to Australia (11,500 mi.) Flight, Which Was Won by Capt. Ross Smith on a Vickers Vimy-Rolls

(c) *Central News Photo Service*

The Caquot Type M Kite Balloon*

Description and Nomenclature

Envelope.—The Caquot type M kite balloon (Fig. 1) has an elongated form with the greatest section about one-quarter the length from the bow. Its length is 82 ft. and greatest diameter 26 ft. 8 in. Its volume is about 32,840 cu. ft.

The following openings are fitted in the envelope:

One inflation inlet located in the bow (*A*).

One valve located on the right side (*B*).

Two portholes of transparent material permitting inspection of the interior of the balloon and ballonet (*C*, *C'*).

One gland for the valve hand control.

One gland for adjusting the automatic valve control in the center of the false valve (*B'*) located on the left side of the balloon directly opposite the valve.

One gland for the ripping control.

Ballonet.—The envelope is kept in shape by a ballonet. Air pressure is maintained by means of an opening from the ballonet into the lower fin.

Fins.—The tail is composed of three fins. As shown in Fig. 2, the outer part of each fin is secured to the envelope by two series of diagonal cords. These enable the ballonet to maintain an efficient shape and insure a firm connection with the envelope.

The lower fin is inflated with air by a scoop at the bottom (*D*, Fig. 1). This fan is connected with the ballonet by a large opening and with the upper fins by two inflating sleeves (*E*, *E'*). These openings are large enough for a man to get through for inspection and adjustment.

Special openings (*F*, *F'*, *F''*) for deflating the fins in camp are placed in the rear.

Valve.—The valve is controlled by the ballonet diaphragm. When the volume of gas increases the diaphragm is driven down. Before the latter reaches its lower limit, it exerts a pull on the valve control through a pyramid of four cords attached to the diaphragm at four points (Fig. 3).

One end of the valve control cord is attached to the valve, and the other to the false valve directly opposite by means of a circular rigging band and cone of eight cords with an aluminum thimble at its apex. By this device the pull of the control cord on the valve is approximately perpendicular to the plane of the latter.

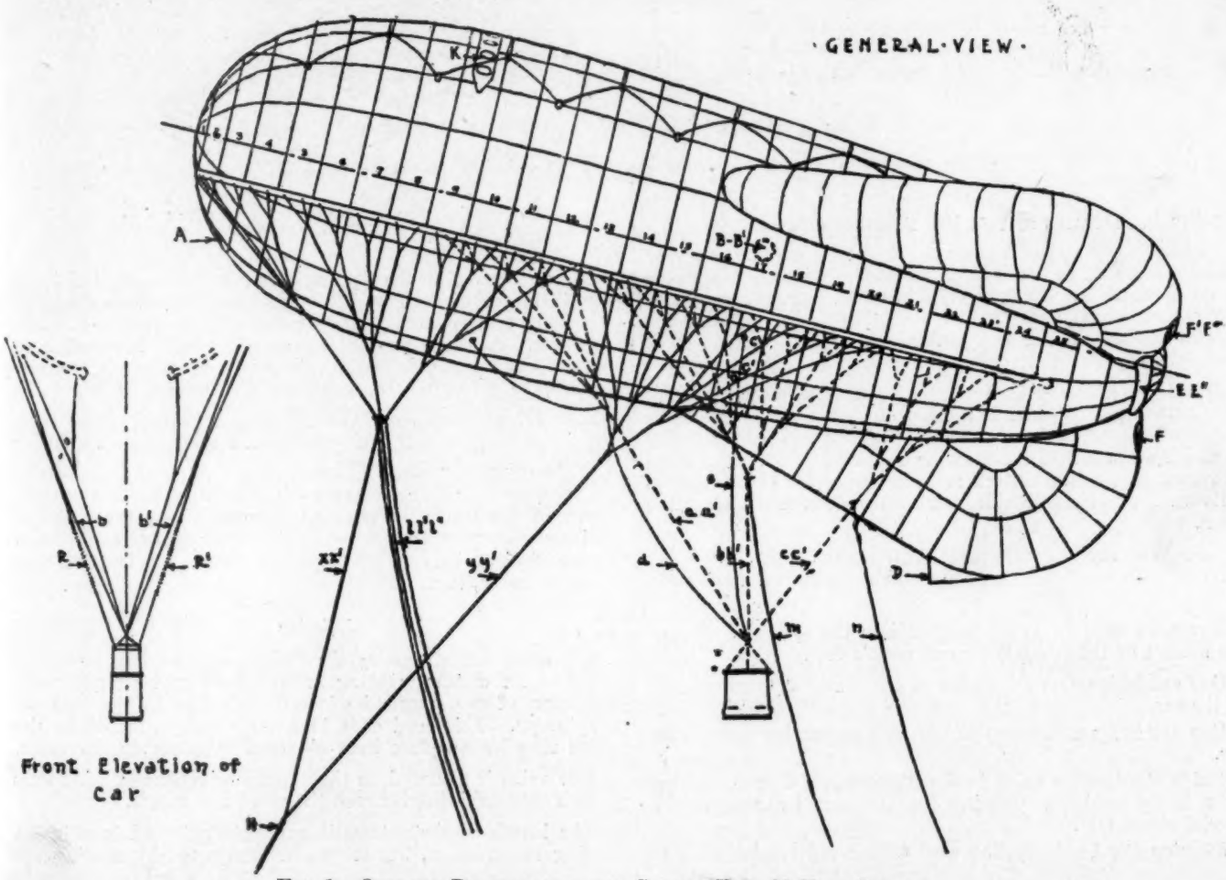


FIG. 1. OUTLINE DRAWINGS OF THE CAQUOT TYPE M KITE BALLOON

Suspension.—The type M kite balloon has two systems of suspensions, as follows:

(*a*) The traction suspension, connecting the balloon with the winch cable.

(*b*) The car suspension, connecting the balloon with the car.

Both of these systems start from the same rigging band and are composed of series of crow's feet, all the elements of which are identical and interchangeable.

(*a*) Traction suspension.—The traction suspension consists of four metal ropes (*x*, *x'*, *y*, *y'*), starting from the lower ends of the two series of crow's feet on each side of the balloon. The ropes meet in a junction piece (*H*), uniting them to the winch cable.

(*b*) Car Suspension.—The car suspension consists of six cords (*a*, *a'*, *b*, *b'*, *c*, *c'*), starting from the lower end of the three series of crow's feet on each side of the balloon. Each pair of cords meets in a toggle, whence two cords run to the ends of the distance bar. Two thimbles for adjusting the stabilizers, which consist of strong rubber shock absorbers, are

* Translated from the French by Lieut. (j. g.) John Jay Ide, U. S. N. R. F. Aircraft Technical Note No. 15, Bureau of Construction and Repair, Navy Department.

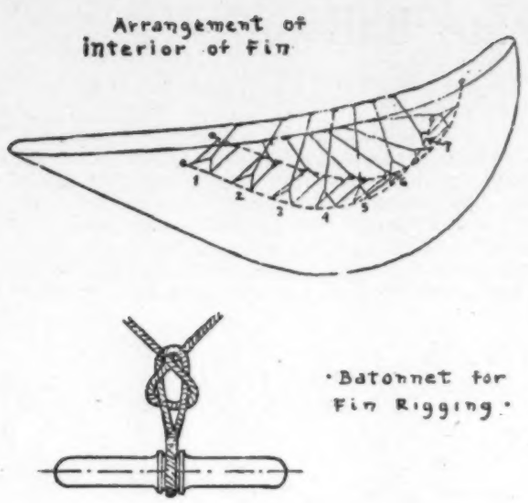


FIG. 2. DETAILS OF THE FIN ARRANGEMENT

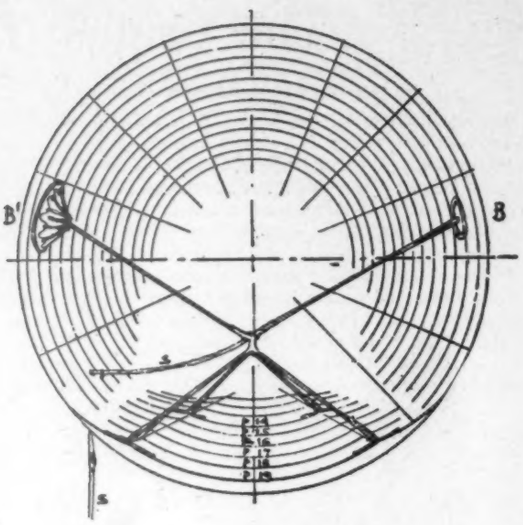


FIG. 3. GENERAL VIEW OF THE VALVE CORDS

likewise attached to the ends of the bar. The car is connected to the distance bar by three cords on each side, the length of the center cords being adjustable. The cords between the toggles and the car are termed the *lower* car suspension, those above the toggles being called the *upper* car suspension.

Mooring Network.—To facilitate mooring a large mesh belt type network is fastened to the top of the balloon. The outer angles of the network carry metal rings, provided with cords, to which are attached the mooring ropes (Fig. 5). The rings corresponding to the sixteen mooring ropes are distributed as follows: seven on each side, one at the bow, and one at the stern.

Car.—The car is of the usual rectangular type.

Grab Ropes.—There are five grab ropes on each side, namely:

Three forward (l, l', l'') toggled into the spliced eyes near the bottom of the front system of crow's feet.

One amidships (m) at the top of the center suspension cord of the car.

One aft (n) near the top of the rear suspension cord of the car.

Valve Cord.—The valve is directly controlled from the car by a hemp cord (s) piercing the envelope by means of a special gland (C).

Ripping Cord.—A ripping cord with a red strand leads to the car. Tearing off the ripping panel uncovers elliptical holes for the escape of the gas. This arrangement insures the same strength at all points, including the ripping portion, of the envelope. A safety device (clamp and ring), attached near each of the two glands of the valve and ripping cords, permits their operation only after a sharp pull of about 30 lb.

Car Telephone Wire.—The car telephone wire starts from the junction piece (H) of the traction suspension and leads directly to the car.

Equipment and Instruments.—The equipment and instruments on board are the same as those used in other types of balloons. In trial ascents the electric anemometer is fastened to the distance bar, or, preferably, between two traction suspension cables, to avoid eddies due to the car.

Inflation

Mounting and Adjusting the Valve.—A cord runs from the valve to the circular rigging band opposite, passing through the apex of the pyramid of cords attached to the ballonet diaphragm. This cord ends in a large loop attached to the valve ring by a square knot obtained by covering the valve.

The valve is mounted on the balloon by means of wing nuts with a rubber gasket between the wood and fabric.

The length of the automatic valve control cord is adjusted during construction, but it can be readjusted by moving the

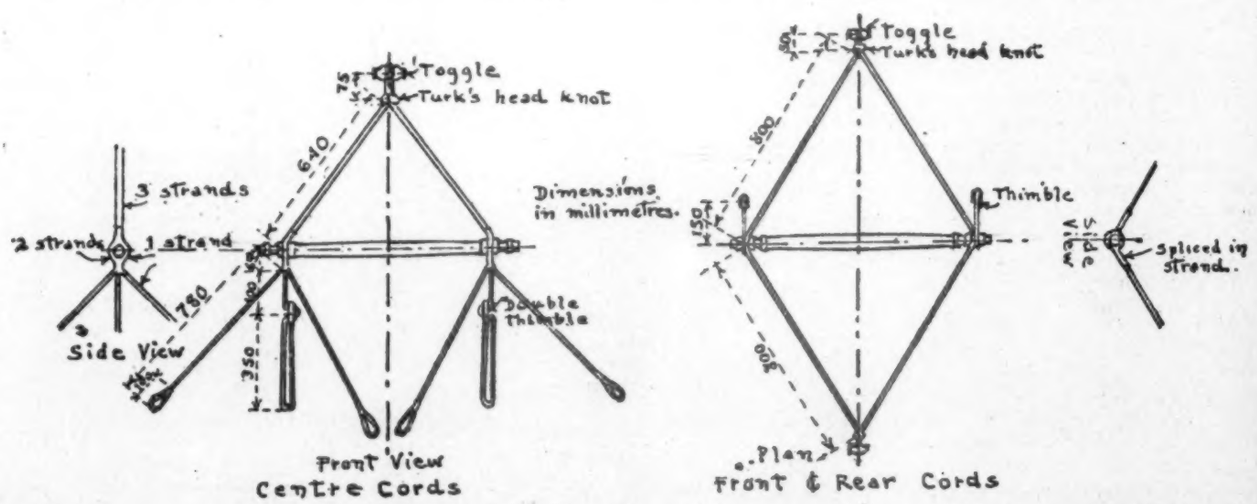


FIG. 4. DETAILS OF LOWER CAR SUSPENSION

turk's head knot bearing against the thimble of the one of eight cords. This knot may be brought to the outside by means of a gland in the center of the circular belt. Adjustment can thus easily be made even on an inflated balloon.

All the cords are made according to gauge and their proper operation is tested by inflating the balloon with air. When the balloon is in service, the automatic working of the valve should be frequently verified.

Inflation.—Spread the balloon upon two ordinary tarpaulins placed end to end so that the wind will be dead ahead of the balloon.

Fasten a few picket ropes to their respective stakes.

Distribute at least eighty sand bags around the equatorial band, hanging them on the first row of crow's feet.

Inflate the balloon. At the beginning of inflation the gas should be limited to the forward half of the balloon by having members of the balloon squad lie across the center. As inflation proceeds, these men gradually move toward the rear. The gas flow should not be checked until the automatic working of the valve has been verified.

Replenishment.—As the inflation pipe is at the bow, the balloon can be replenished by the watch squad alone. It is merely necessary to loosen the picket ropes as the gas flows in. The replenishment is stopped as soon as the sand bags begin to rise from the ground. As the balloon is in the most stable condition when fully inflated, replenishment should be made every evening if possible.

Mooring and Maintenance of Parts

Mooring.—The balloon should, if possible, be moored at the camp so that the bow shall be headed into the wind. The sand bags are distributed around the equatorial band and the picket ropes tied to their respective stakes, as described below:

A light tarpaulin about 26 by 85 ft. is used for camping.

The air in the ballonet escapes by the opening connecting it with the lower fin while the air in the fins escapes through the scoop at the bottom (D) and by the special openings (F, F', F'').

Cover the valve with its cap.

When the balloon is on the ground fasten the grab ropes to camping stakes, one rope to each stake.

If the ground is very soft, drive in long stakes of rough-hewn timber cut on the spot and held in place if necessary by ropes tied to their heads and to other stakes farther back. Rough-hewn stakes hold to soft ground much better than ordinary picketing stakes and they offer a greater resistance to horizontal strains owing to their large bearing surface. For average ground, however, spiral metal stakes are the better.

In case of a high wind the sand bags shall be made fast to a rope running around the balloon forming a belt with one bag on two or three. The rope will be held in place by stakes on the bow, stern, and sides of the balloon.

Maintenance of Valve.—Verify the good working of the valve at the camp and lightly grease the joints.

Maintenance of Rigging.—The type M balloon has been especially designed to permit easy maintenance of the rigging. With this end in view the rigging has been divided into a number of simple units, strictly interchangeable and easily detached. If a unit shows signs of pronounced wear or if a thimble is in poor condition, it can be replaced in the evening at camp.

The box of spare parts contains a large number of rigging units. Each unit should be replaced by a newly made one as soon as it has been put into use on the balloon.

If the rigging is thus kept continually in perfect condition its total replacement will never be necessary and the observer may always feel perfectly safe.

Erection

The principles followed in handling spherical balloons with their grab ropes and brace ropes, apply also to the Caquot type M balloon.

Procedure.—To attach the car to the envelope and to fasten the winch cable to the balloon when the latter is in position, proceed as follows:

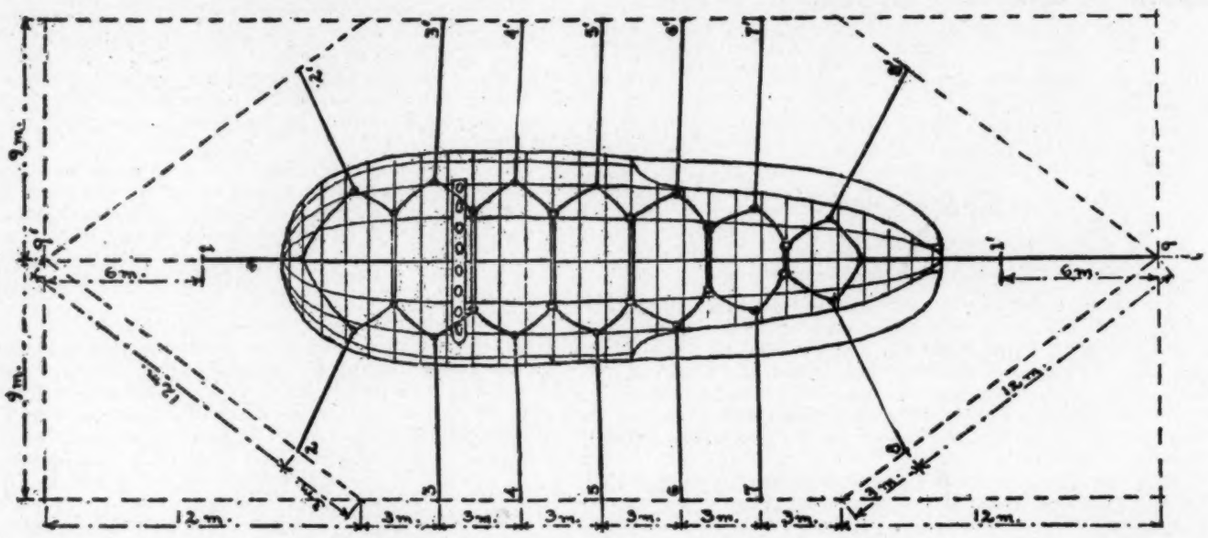


FIG. 5. MOORING ARRANGEMENT FOR TYPE M KITE BALLOON

Untie the picket ropes.

Place the balloon squads at the grab ropes. These squads at once take the "hold fast" position. The corporal in charge of the squad takes hold of the foremost rope with the men of the first row. The second rope is held by the men of the second row, etc.

Have the sand bags lowered by the reserve squad, or if necessary by Nos. 3 and 4 of each rope.

Leave not more than 36 sand bags at the points to which the traction ropes and center suspension cords of the car are to be attached.

Let out the grab ropes gradually as the bags are taken down.

The riggers having charge of accessories attach the traction ropes and join their lower ends to the junction piece.

The car riggers fasten the rubber stabilizers by toggling them to the center suspension cords of the car.

The rigger for the ripping and valve cords is stationed on the left side of the balloon and fastens the ripping cord by a breakable twine to the forward suspension cord of the car.

Have the sand bags removed and let the balloon rise.

When the lowest part of the balloon is 6 feet above the ground, put the car and its suspension cords in place. Slip the loops of the middle suspension cords over the central toggle and those of the forward and rear suspension cords over their corresponding toggles.

Let the balloon rise slowly until the car leaves the ground. Pass the ends of the two stabilizers through their respective thimbles, located at the extremities of the distance bar. Ad-

just the tension and fasten each stabilizer to the opposite end of the bar from the corresponding thimble.

Fasten the valve and ripping cords to the bar, allowing a sufficient amount of slack.

Bring the balloon close to the ground, take hold of the grab ropes near the winch, bring the balloon back a little to allow the riggers to loop the winch cable into the junction piece. Tie the telephone wire of the car to that of the winch cable. Let the balloon rise and let out the ropes by the customary commands.

In case of a strong wind, tie the winch firmly to mooring stakes, so that it can not turn over.

Ascents.—The ascent is made in the same way as with a spherical balloon.

Load of Car.—The car should carry not less than 154 lb. nor more than 374 lb.

Brace Rope Drill.—In this drill the squads in the rear go the first from the brace ropes to the grab ropes and the last from the grab ropes to the brace ropes.

Conveyance by Grab Ropes.—The balloon without the car may be conveyed by hand by the grab ropes. Leave the sand bags at the fastening points, as mentioned above. During the conveyance the balloon must be kept headed into the wind.

TABLE OF WEIGHTS FOR TYPE M BALLOON, 32,840 CU. FT.

Envelope, with rigging	880 lb.
Valve	17 "
Lower car suspension cords	8.9 "
Grab ropes	44 "
Traction cables	19.5 "
Car	70.4 "
Total	1,039.8 lb.

Motor Fuels*

By E. W. Dean

Petroleum Chemist of the Bureau of Mines

The use of vehicles propelled by internal combustion engines is rapidly increasing, and the production of the raw material (crude petroleum) from which the most important type of motor fuel (gasoline) is obtained shows signs of reaching a maximum in the near future. Resources of crude petroleum are obviously limited, and the Bureau of Mines believes it desirable that conservation and efficiency in the production and utilization of gasoline be promoted.

Before attempting to arouse interest in any movement toward conservation it is desirable to furnish fundamental knowledge concerning the present gasoline situation.

There are in use three general methods for the production of gasoline:

(1) The "straight refinery" process, involving distillation of crude petroleum with subsequent chemical treatment and redistillation of the volatile fractions.

(2) The "casinghead" gasoline process, involving the extraction (by compression or absorption) of liquid constituents from certain types of natural gas.

(3) The cracking process, involving the decomposition of heavy petroleum distillates under heat and pressure with the formation of gasoline.

The three types of gasoline differ somewhat in physical or chemical properties, but are all entirely satisfactory as motor fuel if properly produced.

The production of gasoline has increased from approximately 13 million barrels for the year 1909 to over 85 million barrels for the year 1918, a gain of about 560 per cent. The production of crude oil in the United States has during the same period increased only about 95 per cent, while the number of cars and trucks in service has increased about 1700 per cent. This means that, although the petroleum refiner has increased his efficiency more than has the producer, he has not kept pace with the manufacturer of automotive vehicles. The possibility of a motor fuel shortage in the reasonably near future, unless other sources of supply are developed, is indicated by these figures.

Certain seasonal variations in the production, consumption and storage of gasoline may be noted. Production decreases slightly in the winter months and is at a maximum in the summer. Consumption varies considerably with seasonal conditions and is less than production in the winter months and more than consumption in the summer. Stocks of gasoline vary in the same proportion, but in the reverse direction from consumption.

Marketing practice for gasoline is complicated and does not follow general rules very closely. Variations in the price of gasoline are controlled by costs of transportation and demands of consumers as regards quality to a certain extent, but there are hosts of variations.

The most important property of gasoline is its volatility or distillation range. This property is subject to a certain general variation in different parts of the country. The Pacific Coast states receive the most volatile type, the Rocky Mountain states the least volatile. The Atlantic Coast states seem to require and receive gasoline somewhat less volatile than that marketed on the West Coast. The volatility of gasoline marketed in the Mid-Continent states is intermediate between that of the Atlantic Coast and Rocky Mountain states.

Surveys of the grades of gasoline marketed throughout the country were made by the Bureau of Mines in the spring of 1917 and the spring of 1919. It was found that during the two-year period between these surveys a certain degree of change occurred in the general quality of gasoline. The percentages of low boiling fractions remained practically the same, but the end points or upper boiling limits were higher in 1919 than in 1917, the difference being between 25 and 30 deg. Fahr. It is believed, however, that improvements in the design of engines have fully made up for this difference, and that users of motor vehicles are having no more fuel trouble than they had two years ago.

Tests for the presence or absence of acid in gasoline are believed to be of practical value and are usually included in specifications. Tests for the percentage of olefin or unsaturated constituents are of scientific interest, but are not believed necessary in specifications. The widely used gravity test has been shown to lack practical value in indicating the grade and quality of gasoline.

It is believed that oil shale may develop as a resource for motor fuel as petroleum reserves are depleted. Alcohol is also a potential motor fuel of the future, and is already being marketed for this purpose in the form of a blend with coal tar and petroleum distillates. Coal tar distillates are at present the most important type of gasoline substitute, and are to be obtained in markets adjacent to by-product coking plants. They are undoubtedly satisfactory products if properly utilized, but the maximum resources of such fuels are not sufficient to permit them to take rank as more than a slight factor in the problem of gasoline conservation.

* Abstract of an address made before the Franklin Institute, Philadelphia, Pa., Dec. 11, 1919.

Book Reviews

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. (A. L. Dyke, St. Louis, Mo. 940 pp. Many diagrams and illustrations.)

This publication is published with the idea of presenting in clear, simple form the principles upon which gasoline engines and automobiles are built and operated, and to explain in detail all that an operator must know in order that he may operate and care for any make of car or gasoline engine. The practical side of the subject is strictly adhered to and no attempt is made to treat the subject in a theoretical manner.

The principles of the gasoline engine are thoroughly treated, including valve timing, firing, order, carburetion, cooling and lubrication, ignition and electric systems. Installation, care and adjustments for all parts are given, also the analyses of the best oils, greases and gasolines.

One chapter is devoted to a digest of troubles, giving the cause and remedy of each.

The encyclopedia also gives the necessary shop equipment for the repair and overhauling of motors, with instructions for the use of shop tools and welding apparatus, with ample illustrations.

There are several chapters of particular interest to the aeronautical man. These include descriptions of airplane instruments, supplements on the Liberty, Gnome, Curtiss, Hall-Scott and several other aviation motors. Another chapter gives the theory of flight of airplanes, different types, control members and their purpose, and notes on airplane and airship construction.

Navy Specifications for an Amphibian Plane

The Bureau of Construction and Repair, Navy Department, asks under schedule No. 5202 for bids, to be opened Jan. 2, 1920, on flying machines meeting the following specifications:

General Requirements

It is the intent of this schedule to secure proposals for the supply of two-place airplanes capable of use either as seaplanes or as land planes, *complying so far as possible with all the requirements specified herein,* to be built in accordance with Navy Department General Specifications for Airplanes No. 100-A, except as modified by these specifications.

Characteristics

The functions of the new type which it is desired to develop are considered to be as follows:

(a) *A plane for use as a seaplane and for use as a land plane.*

The plane is to be so designed that there is combined in a single landing gear both the landing gear of a seaplane and the landing gear of a land plane, or it is to be so designed that it can be converted into either a seaplane or a land plane by changing the type of landing gear only. The pontoon struts should fit the land chassis strut fittings at fuselage without any readjustment or change.

It is desired to provide an airplane for the use of aviation units serving with expeditionary and advanced base organizations.

(b) *As a land plane.*

The loading per square foot of wing surface and per brake horsepower should be low enough to insure a take-off where only a short run is available, and on ground of the character which is encountered in small fields on expeditionary duty. The plane should have ample propeller clearance and wheels high enough to permit operation over unprepared ground.

(c) *As a seaplane.*

When weather conditions are favorable the seaplane will be lowered over the side of a ship and required to rise with its own power from the sea. The plane shall, therefore, be provided with a suitable hoisting sling (General Specifications 100-A, paragraph 230), readily accessible to the crew of the seaplane and conveniently arranged for hooking on in a swell with ship rolling. The seaplane shall be stable and controllable when running in a moderately rough sea. Particular attention must be given to the protection of the propeller from spray.

Bidders must show in their designs sufficient evidence of seaworthiness to convince the department that the design is worth consideration. Bidders are required to show a stable flotation system; secure against capsizing when at rest on a rough sea; provided with water-tight subdivisions; an excess buoyancy of more than 100 per cent; sufficient clearance under lower wings and tail to keep clear of breaking seas; means for towing consisting of a bridle or lizard secured forward at a suitable point for towing and led back to a point where the crew can conveniently reach it for securing a heaving line.

Favorable consideration will be given to the provision for detaching the wings wholly or in part while adrift at sea. It is contemplated that as a seaplane, the plane will sometimes land in very rough water, and in case of a wreck it is desired that the flotation elements will remain sufficiently intact and buoyant to float the crew until they can be rescued. (General Specifications 100-A, paragraphs 341-6.)

(d) *Maneuvering in the air.*

In the air the plane both as a seaplane and a land plane shall be in proper flying balance, completely controllable, and in all respects a safe and reliable flying machine.

The inherent stability shall be such that pitching motions die out naturally without the intervention of the pilot; the directional stability such that a given course can be held without undue effort that on a turn, if correctly banked, the plane tends to hold this bank; that no abnormal motion is introduced by cutting on or off power. (General Specifications 100-A, paragraph 347.)

(e) *Handling and housing.*

The airplane shall be constructed so as to permit ready assembly and disassembly of the principal parts to facilitate stowage aboard ship. Especial attention must be given to rapid and certain alignment of all fixed surfaces, if possible without need for adjustments. Folding wings or quick detaching wings are desired. The airplanes will be housed in a restricted space, but must be in a condition for service in a minimum time, and in any case on not more than one-half hour's notice. Wing panels shall be less than 25 ft. in length, and in general, careful attention shall be given keeping over-all dimensions of all principal parts to a minimum. All control leads shall be readily accessible and so rigged that correct adjustment of slack is not affected by assembly and disassembly. Gasoline and oil piping and engine controls should be so rigged as to be unaffected by disassembly of the airplane for storage. The complete power plant should remain assembled as a unit.

(f) *Handling crates.*

The parts of the airplane are to be so distributed among the various crates that they can be readily handled and transported by manual labor without the use of special equipment. The crates shall be reasonably water-tight and so constructed as to permit ready reassembly and recrating, and sufficiently rugged to permit of rough handling.

(g) *Air performance.*

When carrying a useful load of 1200 lb., representing such items as the department may designate, the airplane shall meet the following performances:

(1) As a land plane, the minimum performance shall be as follows:

Low speed.....45 m.p.h. at sea level
High speed.....90 m.p.h. at sea level
Climb in 7 min.....5000 ft.

(2) As a seaplane, it shall approximate at least the following:

Low speed.....48 m.p.h.
High speed.....85 m.p.h.

(h) *Endurance.*

These planes shall have a cruising range of at least 300 mi., necessitating from three to four hours' fuel capacity.

Particulars to Be Forwarded with Proposals

Particulars to be forwarded with proposals shall be in general as required in General Specifications 100-A, Section I, except such items as may be waived by the Navy Department, for the plane both as a seaplane and as a land plane. In addition there shall be furnished complete drawings of the handling crates, showing the method of construction and overall dimensions of packages when ready for storage aboard ship.

Load Definitions

The terms "light load," "full load," etc., shall be understood to be defined as given in General Specifications 100-A.

INSTRUMENTS

No.		Weight. lb.	Furnished by Navy Dept.
1	Air Speed Meter Gauge		" "
1	Air Speed Meter Venturi Tube		" "
1	Inclinometer—Universal		" "
1	Altimeter		" "
1	Navy Standard I Compass		" "
1	Keyless Clock		" "
1	Oil Thermometer		" "
1	Water Thermometer		" "
1	Oil Pressure Gauge		" "
1	Air Pressure Gauge		" "
1	Tachometer		" "
	Instrument Lights		" "
	Electric Wiring and Switches		" "
	Extra Weight Allowance		" "
	Total Weight Allowance	50 lb.	

ORDNANCE

No.		Weight.	Furnished by Navy Dept.
2	Fixed Browning Guns	40 lb.	" "
2	Fixed Browning Gun Synchronizers	14 "	" "
	Fixed Browning Gun Ammunition, 2 Belts 500 Rounds	50 "	" "
1	Lewis Gun	20 "	" "
1	Lewis Gun Scarff Mount	25 "	" "
	Lewis Gun Ammunition, 3 Mag. 97 Rounds each	30 "	" "
1	Lewis Gun Ammunition Tray	2 "	Contractor
1	Set Colt, Very's Pistols, Rockets & Ammunition	20 "	Navy Dept.
	Bombs	160 "	" "
1	Set Army Mark V Bomb Gear	50 "	" "
	Wimperis Mark I-A Bomb Sight	9 "	" "
	Total Weight Allowance	420 lb.	

EQUIPMENT

No.		Weight.	Furnished by Navy Dept.
1	Set Radio Telephone & Telegraph	110 lb.	" "
1	Set Intercommunication Set	10 "	" "
1	Set Camera and Supplies	10 "	" "
1	Pressure Fire Extinguisher	8 "	" "
2	Hand Fire Extinguishers	12 "	" "
2	Safety Belts	5 "	" "
1	Sea Anchor	10 "	" "
1	Heaving Line	5 "	" "
1	Food	10 "	" "
	Extra Weight Allowance	.. "	" "
	Total Weight Allowance	180 lb.	

Power Plant

The power plant shall include the following:

Fuel System.	Furnished by Contractor
Gas Tank with Gauge	"
Oil Tank with Gauge	"
Gas Piping	"
Oil Piping	"
Extra Weight Allowance.	
Total Weight Allowance.	
Power Plant,	
Engine,	
Magneto,	
Carburetor,	
Air Pressure Pump,	
Hand Air Pump,	
Starter,	
Engine Controls,	
Propeller,	
Radiator,	
Water Piping.	
Extra Weight Allowance.	
Total Weight Allowance.	

Note.—Bidder to indicate items (type and manufacturer) he proposes to furnish under contract.

Further details in regard to the provisions and intent of this specification, as well as copies of all Navy aeronautical specifications, may be obtained by consulting the Bureaus of Construction and Repair, and Steam Engineering, Navy Department, Washington, D. C.

Engine Rules for Pilots

The following engine rules are furnished Air Service pilots and are published in the News Letter for the interest of all concerned outside of the Service:

In order that an engine may give a maximum length of service two things are essential—first, that it never be suddenly accelerated or decelerated; and second, that it never be allowed to race in the air.

In reference to the first point, sudden acceleration or deceleration of the engine causes sudden changes in temperature which result in warping of parts. Especially is this true of valves, and the majority of valve trouble is started this way. A very slight warpage of the valve will cause the valve to burn and a missing cylinder results. The extent of this trouble varies with different engines. Sudden changes in temperature also set up strains in other parts which weaken them and may result in a permanent injury.

With this in mind, all pilots on starting an engine should warm it up gradually. It should be idle just fast enough to keep all cylinders firing until the temperature is at least 60 deg. Cent. In cold weather it may be necessary to run a little faster, but it must be remembered that when the engine is cold the oil is thick and there is danger of cavitation in the oil line if the engine is speeded up. When the engine is thoroughly warmed up it may be gradually opened wide for a short time to insure that it is working properly, but continued running with open throttle on the ground will cause overheating.

In taxying the throttle should never be suddenly opened or closed unless it is absolutely essential. In taking off the same is true. It is not necessary to suddenly push the throttle open. Take it easy—the results are far more satisfactory.

In the air, unless you are actually engaged in stunting, the engine should be partly throttled. The airplane will handle better, the life of the engine will be lengthened, and the cruising radius will be increased. The Hispano-Suiza and the Liberty are high-compression engines and designed for full throttle only at high altitudes. Never let the engine race—keep the nose up or throttle the engine. In stunting, throttle whenever the engine races—don't go into a glide or slip with the engine full on.

When you close the throttle, close it slowly. If the throttle is jerked closed, the valves, which are running at a cherry-red heat, will cool suddenly and a warpage will result.

Another source of trouble is that of fouling of plugs, and it is almost entirely the fault of the pilot. However well the engine may be adjusted, abuse in the air can result in fouled plugs. In a glide the engine must be kept warm. It should not be allowed to go below 70 deg. Cent., and the throttle should be repeatedly opened to clear out the cylinders. When the engine is allowed to cool to too low a temperature, contraction of the pistons allows too much oil to be "pumped" into the combustion chambers and the plugs will be fouled. The temperature may be kept up by the use of shutters if they are available, and by the proper adjustment of idling speed.

Another point to be remembered in allowing the engine to cool too much is that the carbureters are adjusted to use the least possible amount of fuel when the engine is well warmed up. With this adjustment a cold engine will not respond rapidly to the throttle, and will not be available in close quarters when power may suddenly be required.

A common mistake made in starting an engine is that of flooding. In cold weather it may be necessary to prime the engine, but this should not be overdone, as it is easier to overcome too lean a mixture than one too rich. The Liberty may be primed by the use of the Lunkenheimer primer on the dash and the Hispano-Suiza through priming cocks on the manifold. The charge should be taken into the engine with the throttle nearly closed, and no time should be lost between the taking in of the charge and its ignition, as only a short time in a cold engine is sufficient to cause the "fog" of the gasoline in the intake pipes and cylinders to condense. The propeller should be "placed" quickly and the pilot should be ready to turn the starting magneto as soon as "clear" has been called. If the engine is flooded it may best be cleared by turning the propeller backward.

In conclusion, it is desired to emphasize the fact that the engine's performance and length of life depend largely on the pilot. If the engine is running all right when you take it, and an airplane should never be taken with the engine missing or failing to turn up to its proper r.p.m., it will continue to do so except in exceptional cases, if you handle it properly. Many of the pilots used Curtiss OX-5 engines in their training, and make the mistake of thinking that other engines should give the same performance. They do not stop to think that the Curtiss OX-5 was designed to stand abuse, while in the design of such engines as the Hispano-Suiza and the Liberty performance was given the greatest weight. Failure to obtain good performance from the latter engines is a perfect indication that the pilot does not understand them.

Security of Airplanes in Flying Over the Sea

This article deals with the provision of collapsible floats which can be instantaneously filled with compressed air at the desired moment. The idea is due to Colonel Busteed, and has been developed both by him at Grain, and by Lieut. Bonnet-Labranche in France. The air floats have been fitted on some hundreds of British and French airplanes patrolling the North Sea, the Channel and the Mediterranean, and many aviators owe their lives to them. Airplanes fitted with these floats have been largely employed on airplane carrier ships in place of seaplanes, which are, of course, much less efficient.

Two or more floats of rubbered fabric are rolled up and stowed under the wings or under the fuselage, and these can be filled by means of a compressed air outfit in 30 secs. The number of bottles of compressed air required is reduced considerably by the addition of an injector with 3 concentric cones, inserted in the pipe leading from the compressed air bottle or bottles to the float bags. A jet of the compressed air issues from a fine nozzle, whose walls are divergent towards the orifice, and by its expansion draws a large quantity of the external air through the triple opening between the three cones.

Several reservoirs of air in rubber bags are symmetrically arranged in the fuselage frame-work, and connected by tubing provided with taps by which the pilot can partially deflate them at altitudes. A hand-pump allows loss of air pressure due to leaks during long flights to be made up.

The wheels of the chassis may in some cases be dropped off before alighting on the sea.

In addition a hydrovane is fitted in front of the chassis to prevent too great a shock to the inflated floats on alighting.

A machine weighing 1,000 kg. requires floats of an aggregate volume of 2,000 litres. (*L'Aérophile*, September, 1919.)

The Bureau of Standards Carburetor Test Plant*

By Percival S. Tice

The Bureau of Standards carburetor testing plant was designed and built for the purpose of insuring greater precision and speed in observations of carburetor metering characteristics than are conveniently possible where the carburetor is in use on an engine. It is designed to permit observations not only at atmospheric pressure and temperature, but also at air pressures as low as one-third of an atmosphere, and at such temperatures as may be desired above atmospheric temperature. Means are also provided for producing pulsations of the air flow, comparable in speed and amplitude to those met with in practice. Thus it is possible to reproduce substantially any condition which may obtain in service on an engine, and at the same time variables due to the engine condition are eliminated. The course of the investigation is so simplified as to make it possible for one man to control the whole plant and make all observations incident to a set of runs. While

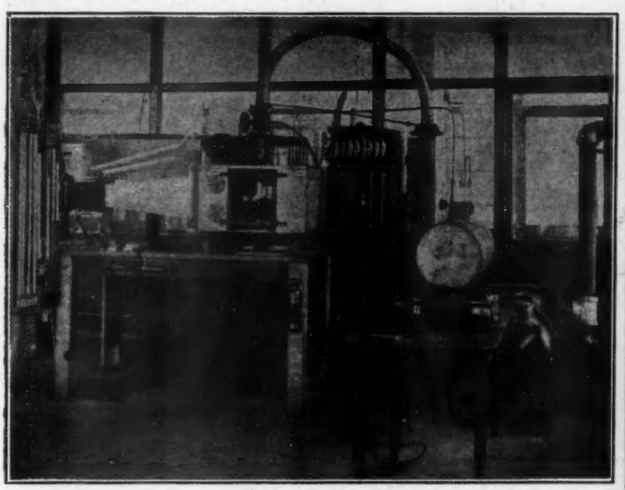


FIG. 1. GENERAL VIEW OF THE CARBURETER TEST PLANT

the results obtained usually require checking on an engine in operation, the final stage is reached more quickly, conveniently, and at far less expense, as well as more accurately than if all the tests had been made on the engine.

The set-up comprises the following several units: (1) The air meter. (2) The throttle valve. (3) The air heater. (4) The carburetor chamber. (5) The pulsator. (6) The air pump. (7) The fuel meter. (8) The manometer columns.

To follow the course of the air through the plant: It first passes the air meter, then flows through the throttle valve and over the heating grids to the carburetor chamber. Here it enters the carburetor under observation, after which it passes through the pulsator to the blower pump, from which latter it is discharged to the atmosphere.

The general appearance and arrangement of the plant are shown in Fig. 1, in which view the convenient grouping of the controls is clearly brought out.

A detailed description of the several units of the plant follows:

The Air Meter

This portion of the plant follows exactly the specifications laid down by Durley† in his work on air flow through orifices in thin plates, with the one exception that the direction of flow is reversed with reference to the orifice box or chamber. Since, however, the cross sectional area of the chamber in a plane parallel to that of the orifice is somewhat over the limiting value of 20 to 1 referred to the maximum orifice area employed, and since the drop in pressure across the orifice is never permitted to exceed 6 in. of water column, the fact that the air flow is into instead of out of the chamber is of no consequence in the measurements.

Fig. 2 is close-up view of the orifice end of the metering chamber. Here are shown the approach passage with its grid for the purpose of protecting the lines of flow into the orifice from disturbance by stray room currents, and the structural details of the orifice mounting. The orifices are bored in steel plates 0.057 in. thick, with perfectly square edges, and range in size from 3.500 in. to 0.500 in., by 0.500 in. decrements.

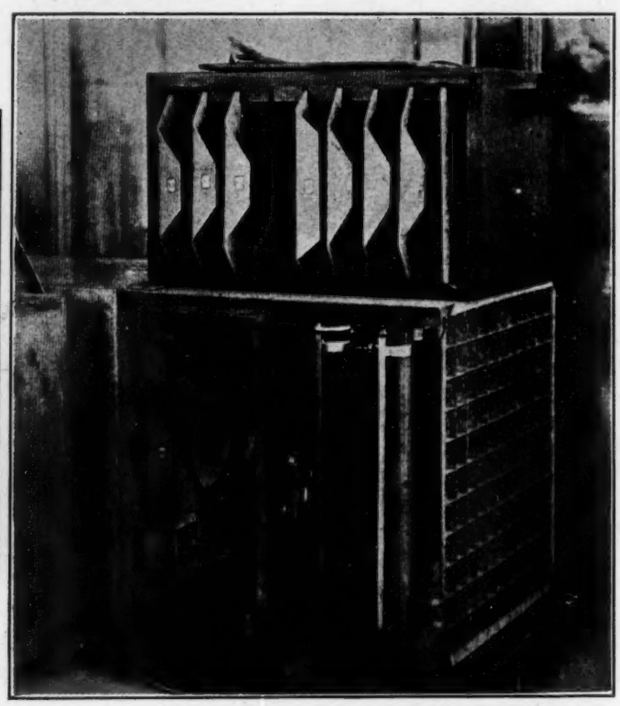


FIG. 2. AIR METERING ORIFICES

There is provided in addition, an orifice of 0.3125 in. diameter, and also a blank plate used for checking the tightness of the chamber and throttling valve. The orifice plates seat upon a rectangular gasket of pure gum rubber of ¼ in. thickness, thus insuring air tightness even though the plates are sprung in locking them upon the end of the chamber.

The pressure drop across the orifice is read on the upper of the two inclined manometers shown above the pyramidal approach to the carburetor chamber, Fig. 1. This manometer is provided with a scale having divisions 1 mm. apart, and is set at such an angle that each division is equal to a vertical rise of the column of 0.01 in. This readily permits an accuracy of observation of plus or minus 0.0025 in. on the deflection of the column. In addition there is provided a short vertical water column, at the immediate left of the carburetor chamber, having a scale divided into fiftieths of an inch, and read through a magnifier, with provisions for the avoidance of parallax. This latter column is fitted with a tank having one hundred times the area of the tube, thus its readings are at all times 1 per cent too small. While the inclined column is also connected with a tank (in this case a Wolff bottle at the back of the board) the inclination of the tube is so adjusted that no correction need be made.

The Throttle Valve

A length of 3-in. pipe connects the orifice chamber with the gate valve shown in the foreground of Fig. 3. The function of

* From Report No. 49 of the National Advisory Committee for Aeronautics.

† R. J. Durley, Trans. A. S. M. E., xxvii, 193. The reader is referred to this original paper for complete discussion of the desirability of employing flow through orifices in making air measurements.

this valve is the control of the pressure within the carburetor chamber, in a study of the performance characteristics of carburetors under atmospheric pressures lower than that at the ground. The manipulation of the throttling valve will be discussed in detail in that section of the description devoted to the method of control.

The Air Heater

For the purpose of observation of the effects of varying air temperature on carburetor performance the air, after it has passed the throttling valve, is drawn through a chamber composed of a set of five frames, in each of which is mounted a

FIG. 3. END VIEW, SHOWING THROTTLING VALVE AND MANOMETER LINES

coil of resistance wire in such a manner as to cause it to be reasonably completely swept by the air stream. As shown in Fig. 4, the five units of the heater are wired to controlling switches and a rheostat in such manner that three of them are supplied with current at 220 volts, without external resistance, when their respective control switches are closed, while the fourth may be thrown into circuit on either 110 or 220 volts as desired. The fifth unit is in series with a rheostat, and may also be supplied from either the 110-volt or the 220-volt lines, as required.

The capacities of the units are identical and the control is such as to permit of extremely delicate regulation from about 3 deg. above the atmospheric temperature up to 45 deg. cent. above that temperature, with the maximum air flow of which the plant is capable. Chamber temperatures are read on a mercurial thermometer mounted just within the glass door, as in Fig. 1.

The Carburetor Chamber

Leaving the heater, the air passes through the pyamidal approach passage to the carburetor chamber. Mounted in the entrance to the latter is a grid similar to that shown in the approach to the air metering orifice. The increasing sectional area of the approach to the carburetor chamber and the grid just mentioned are designed to obviate to a large extent the eddy currents that might be expected to exist within the chamber should the air be introduced in a column of small section at higher velocities.

The carburetor chamber comprises a box 18 by 18 in. at the ends (outside) and 30 in. long (outside), built up of yellow-pine boards 2 in. thick. Inside, at each junction of abutting walls, the structure is reinforced by a fitted length of 2-in. angle iron. The door opening is recessed to take a steel frame made up of ¾-in. square stock, the outer face of which is flush with the face of the chamber. Over the whole is fitted a solder-sealed sheathing of galvanized iron, and supported by the turned-up edge of the sheathing at the door opening is a rectangular gum rubber gasket, ¼ in. thick, having a ¾-in. face. The glass door, shown in Fig. 4 resting on the table beneath the carburetor chamber, is of plate glass, ¾ in. thick, and is supported and clamped in place over the opening and against the gasket by the pair of steel bars shown at the top and bottom of the opening.

The heavy construction of the chamber is necessitated by the great pressure to which the walls are subjected when the pressure within the chamber is reduced, as in studying high-altitude performance of carburetors. The sheathing of galvanized iron is employed to insure air-tightness. This form of sheathing is also applied to the pyramidal approach, and to the orifice chamber.

Within the carburetor chamber, and in the center of its top wall, is mounted a circular flange to which the several carburetors studied are secured with interposed adapters. At the left of the door opening is a pair of control spindles, with adjustable levers inside the chamber, for the control of the throttle and whatever other control member may be provided in the carburetor.

A sleeve, integrat with the carburetor flange within the chamber, extends through the top wall to form an air-tight joint with a large circular flange secured to the outside of the chamber.

The carburetor outflow passage consists of a glass tube held in glands spaced by four ⅜-in. studs. Several advantages result from making this portion of the outflow passage of

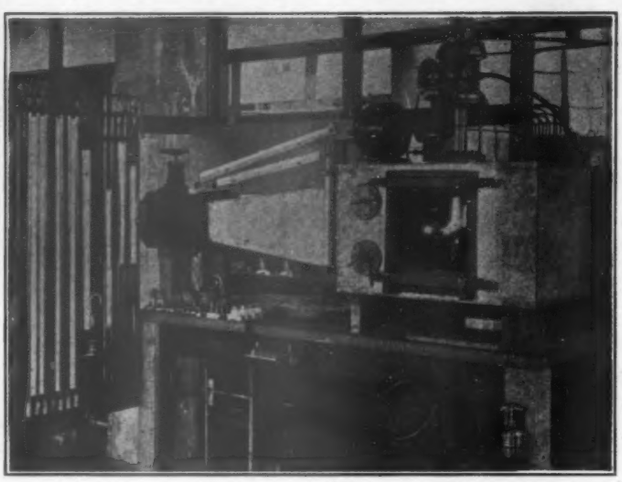


FIG. 4. THE AIR HEATER, CARBURETER CHAMBER, PULSOMETER AND MANOMETERS

glass. The quality of the charge, with respect to the fineness of division of the liquid, is shown; irregularities in the fuel discharge are made obvious; it can be seen whether or not the passages of the carburetor cause swirling of the air stream; and localization of the liquid in the stream or on the wall is definitely shown. In addition to the above, observations of the glass serve as a ready check on the functioning of the float mechanism of the carburetor.

The Pulsator

Mounted just above the carburetor discharge passage is the pulsator, a device for creating pulsating flow through the carburetor, closely following in character those fluctuations of pressure and velocity experienced in the operation on an engine. The exterior of the pulsator is shown photographically in Fig. 4, and its construction and control are diagrammed in Fig. 5.

The pulsator body is a casting with a rectangular passage for the mixture discharged by the carburetor. Normal to and intersecting the axis of the passage is a spindle carrying a rectangular throttle plate. Secured to the front and the back walls of the rectangular passage are plates of spring bronze, which are normally flat, and cause no restriction of the pas-

sage. These spring plates form flexible walls for the passage, and permit of varying its effective area in the plane of the throttle spindle.

A one-sixth horsepower shunt motor, mounted on the top of the carburetor chamber, is arranged to drive the pulsator spindle through three-step pulleys. The control of the speed is supplemented by field resistances; and a magnetic tachometer is used to show the speed of the spindle. These latter items are shown in Figs. 1 and 2, mounted on the front wall of the metering orifice approach passage. The tachometer is one built for cam-shaft drive on an engine and thus reads directly in pulsations per minute, since the pulsator throttle sweeps the passage twice for every revolution. The range of control provided permits of a change in rate of pulsations from 600 to 4,000 per min. This is equivalent to a range of

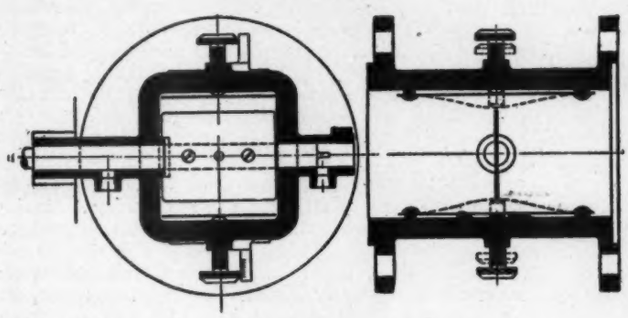


FIG. 5. DIAGRAM OF THE PULSATOR

engine speeds from 300 to 2100 in the case of four cylinders, and from 400 to 2800 r.p.m. in the case of three cylinders per carburetor.

The amplitude of the pressure pulsations is controlled by manipulation of the screws shown in Figs. 4 and 5, to cause the spring plates to approach the edges of the throttle plate more or less closely as the throttle revolves. Thus it is possible to reproduce sufficiently faithfully for the purpose in hand, the pulsation characteristics of any engine cylinder combination of more than one cylinder, having the aspiration strokes evenly spaced.

A simple form of optical indicator is employed to show the magnitude of the pressure fluctuations in the carburetor discharge passage. This indicator is shown in diagram in Fig. 6. No attempt is made to make a pressure-time diagram of the pulsations. The magnitude of the pressure fluctuations is read from the calibrated screen of the indicator, on which appears a line of light, the ends of which define the values of the upper and lower pressure limits.

The Air Pump

A Nash "hydroturbine" vacuum pump is used to draw the air through the carburetor. Its intake is connected with the pulsator outlet by a length of flexible metallic tube, as shown in the general view, Fig. 1; and the pump discharge is carried out through a window of the laboratory.

Between the pulsator flange and that on the end of the flexible tube is a throttling opening and trap. This latter serves the double purpose of eliminating the effect upon the carburetor of resonance in the length of flexible tube when the pulsator is in action, and of trapping and passing directly to the pump the liquid that would otherwise accumulate above the pulsator with small air flows. This liquid passes to the pump intake through an inclined length of ⅜-in. pipe.

The Nash pump is that company's No. 3 size, and is capable of reducing the pressure within the carburetor chamber to 180 mm. Hg., or to 180/760=0.237 atmosphere, with the throttling valve fully closed. Between the limits of the barometer column of 350 mm. and one of 760 mm. the weight of air pumped is a straight line function of the pressure. The capacity of the pump as applied to this plant is shown graphically in Fig. 7, in which the weight of air pumped is plotted against barometric pressure and also against pump speed at a chamber pressure of 740 mm.

The Fuel Meter

Reference to Fig. 8 shows the details of the fuel-weighing method. A 30-gallon tank is mounted on a platform scale, and supplies the carburetor float chamber through on overhead line, by virtue of a pressure difference maintained between its interior and that of the carburetor chamber. The tank is provided with a gauge indicating the pressure applied to the fuel; and a pressure regulating valve in the line is adjusted to maintain a pressure difference between the tank and the chamber of 2 lb. per sq. in. After passing the pressure regulating valve, the fuel enters a vapor trapping chamber set upon the tank, and from this point flows through a line ⅜-in. (o. d.) copper tube to a valve and fitting in the top wall of the carburetor chamber. From this fitting, the connection with the carburetor is completed through a length of airplane fuel hose.

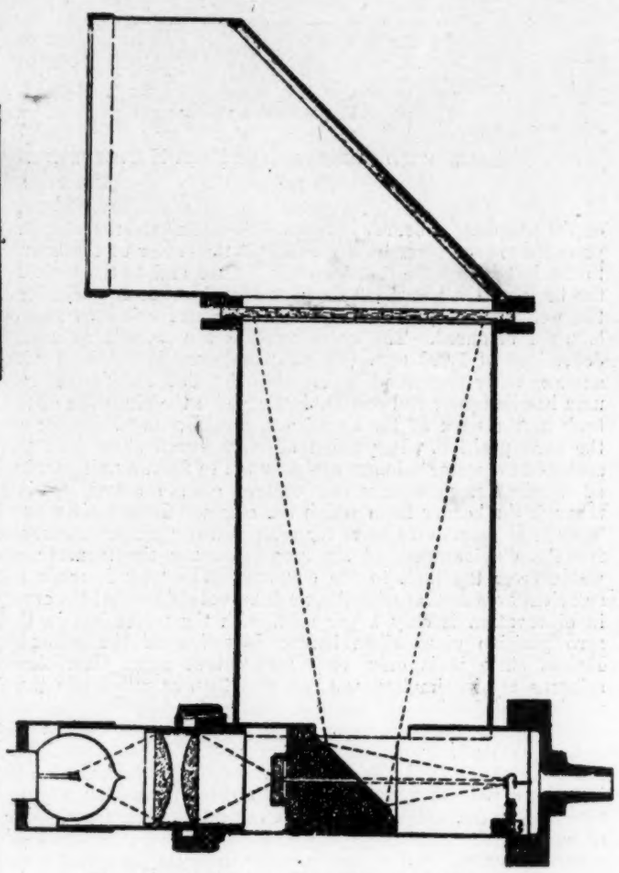


FIG. 6. DIAGRAM OF THE PULSATION INDICATOR

The beam of the scale is fitted with a contact arm, which upon falling of the beam dips into a mercury cup and completes a circuit through a magnetic apparatus controlling the starting and stopping of a stop watch. Closure of the circuit through the watch control also completes the circuit through an annunciator, thus drawing the attention of the operator to the fact that a run has started or ended, as the case may be. This method of timing a weighing possesses the advantages of making the weighing automatic, and eliminating the personal equation in the operation of the watch, and of permitting the operator to devote his attention to the controls and the making of observations throughout a run.

The Manometer Columns

A rectangular flange soldered to the carburetor chamber sheathing carries twelve union fittings to which are secured twelve manometer lines of ¼-in. (o. d.) copper tube. The union fittings extend into the chamber approximately 1½ in. beyond the walls, and to them can be connected with rubber tubing the several points about a carburetor at which it is desired to take pressure observations. The manner in which the manometer lines are carried to the board supporting the columns is clearly shown in Figs. 1, 3, and 4.

One of the manometer lines, the seventh from the left side

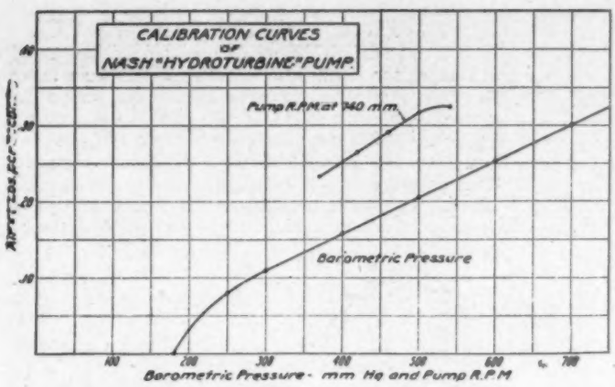


FIG. 7. CALIBRATION CURVES OF THE NASH HYDROTURBINE PUMP

of the manometer board, is used to communicate the chamber pressure to barometer located at about the center of the board, to the left leg of the first mercury U tube and to the tank on the back of the board. This tank contains water, and forms the well against which the set of six water columns, at the left, are balanced. The water columns are capable of useful deflections of 1,020 mm. (40 in.); and each is provided with a needle valve shutoff. The seventh and middle short water column has its upper end communicating with the air space of the tank at the back of the board and serves as an indicator of the zero position. Inspection of Fig. 4 will show that the scales of the water columns are mounted to form a unit capable of vertical movement under control of the screw passing through the header from which the columns draw their water. Thus it is possible to reset the scales during a run to correct for the displacement of the zero following the transfer of water from the tank to the columns. The tank is made of sufficient area so that with three columns standing full the error in observation is only 1 per cent, with the scales left in the zero position given them before deflection of the columns. Hence, since it is only very rarely that more than three columns are in simultaneous use, and then at much less than maximum deflection, the error in observation without resetting of the zero is ordinarily well within 1 per cent.

In addition to the six water columns discussed, and the main barometer for indicating the chamber pressure, the board includes a pair of mercury U tubes, and a supplementary U-tube barometer. Both legs of the second U tube are capable of connection within the chamber, for making differential readings not referred to the chamber pressure, or for making plus pressure observations. The auxiliary barometer tube is used where it is desired to make direct observations of absolute pressure at some point about a carburetor. It is obvious that by use of T fittings and tubing within the chamber the columns can be interconnected in any combination that may be required to fit the case under observation.

Method of Operation

Most of the work that has been done in the carburetor testing plant has been with special reference to the requirements of certain aeronautic type engines, and as a consequence the weights of air to be taken through the carburetor under given surrounding conditions have been well established beforehand by direct observations on the engines themselves in the Bureau of Standards' altitude laboratory. This points out one of the chief uses of the plant, in that special requirements of individual cases, as well as the desirable range of operability of a carburetor, can be studied in detail and with a maximum of convenience and a minimum of cost and lost motion.

The 25-hp. motor used to drive the pump is a shunt type, and is provided with resistances in the field circuit for effecting control of the pump speed. These resistances are shown on the table sill in Figs. 1 and 4.

With the pump in operation, the amount of air taken through the carburetor is controlled by (1) the position of the carburetor throttle, (2) the position of the throttling valve between the meter chamber and the air heater, and (3) the position of the gate valve on the pump intake, which faces the driving motor beneath the table and is controlled by the wheel at the table edge, as in Fig. 1. This latter valve controls the depression in the carburetor outlet, and in this way the air taken through the carburetor. The throttling valve, on the other hand, controls the amount of air pumped, through its influence upon the pressure, and therefore the density of the air in the carburetor chamber.

Assume the case where it is desired to take a given weight of air through the carburetor at a given barometric pressure and with a given pressure drop in the carburetor outlet, corresponding to a run under partial throttle opening. Having located a suitable orifice in the entrance to the meter chamber, the pump intake by-pass valve and the throttling valve are adjusted to give the required deflection of the orifice manometer at the required chamber pressure. This establishes the air flow referred to the chamber pressure, and so long as the throttling valve remains undisturbed, subsequent adjustment will realize the one when the other is realized. To complete the setting of conditions, the carburetor throttle position is adjusted in combination with the pump intake by-pass, to give the required carburetor outlet pressure at the chamber pressure previously set. When this is attained, and it is very speedily accomplished, all three pressures are at the desired values.

One of the chief functions of the plant is the accurate determination of the ratio of air to fuel in the mixture. Having set the air flow and other conditions incident to it, as above, the weights on the fuel scale are adjusted so that the beam is about to drop. When this occurs, through removal of the liquid from the tank under demand by the carburetor, the circuit through the watch control is closed and the watch started. The required weight is now removed from the scale beam, and the operator is free to record his observations of pressures, temperature, pulsator speed, and amplitude, and to maintain the setting, should this be required, while the run goes on. When the predetermined weight of fuel has been metered by the carburetor, the scale beam again drops, stopping the watch. A record of the time taken for the given weight of fuel completes the run.

For convenience, graphs have been prepared showing the discharges in pounds of air per second plotted against difference in pressure for each of the several metering orifices included in the equipment. Other charts are developed for special cases, and will be discussed in detail in those reports dealing with the cases in which they are used.

In general carburetor development work, that is, without special reference to a particular engine or class of service, the extreme flexibility of the plant permits the whole usable range of operation to be investigated under any and all of the combinations of conditions likely to be met in service.

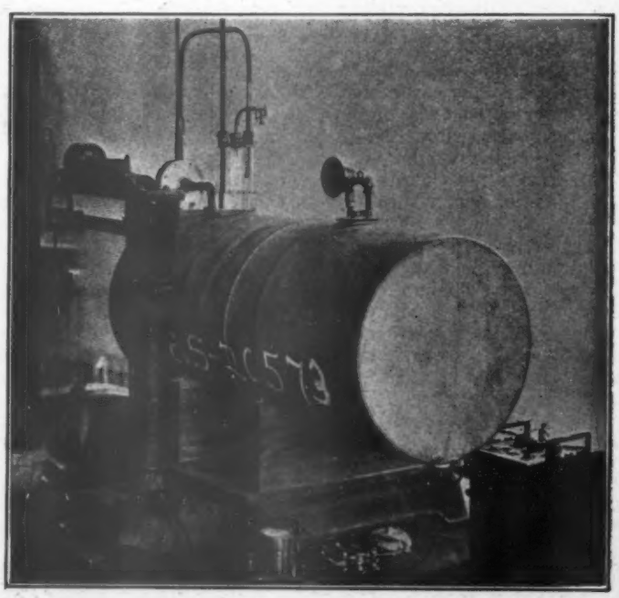
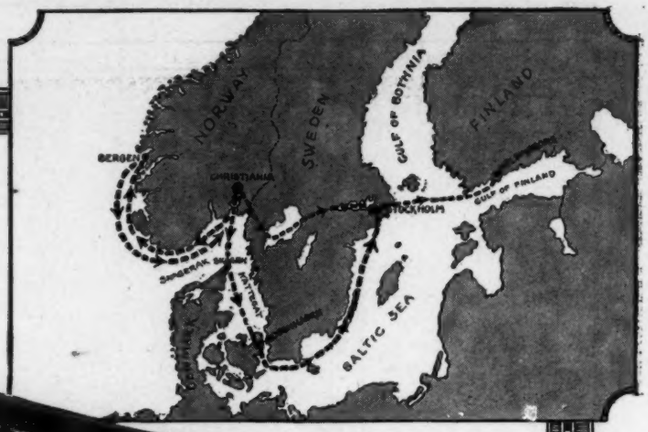


FIG. 8. FUEL METERING OUTFIT



Curtiss

Flying Boats make good Everywhere

"Tomorrow morning we expect to fly from here (Stockholm) to Helsingfors (Finland). We have already flown from Kristiania to Bergen and back; from Kristiania to Skagen, Denmark, over Skager-Rak; also from Skagen to Copenhagen over Kattegat; from Copenhagen to Stockholm, Sweden, around the Baltic Coast, and now across the Baltic to Helsingfors.

Part of letter from Mr. John M. Larsen, Stockholm, Sweden

Fortunes In The Air

THIS doesn't mean that air-traffic is visionary or uncertain, but just the opposite.

For there are real fortunes in the air for those who can pilot an airship and who "get busy."

More than one aviator has made the cost of his Curtiss aeroplane or flying boat the first week carrying passengers and making exhibition flights. There are untold commercial opportunities awaiting you.

There is a splendid opportunity for dealers to become identified with this profitable industry. Get in on the ground floor by writing for our sales plan for your territory.

145

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Member Manufacturers' Aircraft Association

THOMAS-MORSE

Tandem 2-Seater, Type S-6

Equipped with 80 h. p. Le Rhone Engine.

High speed, 105 M. P. H.

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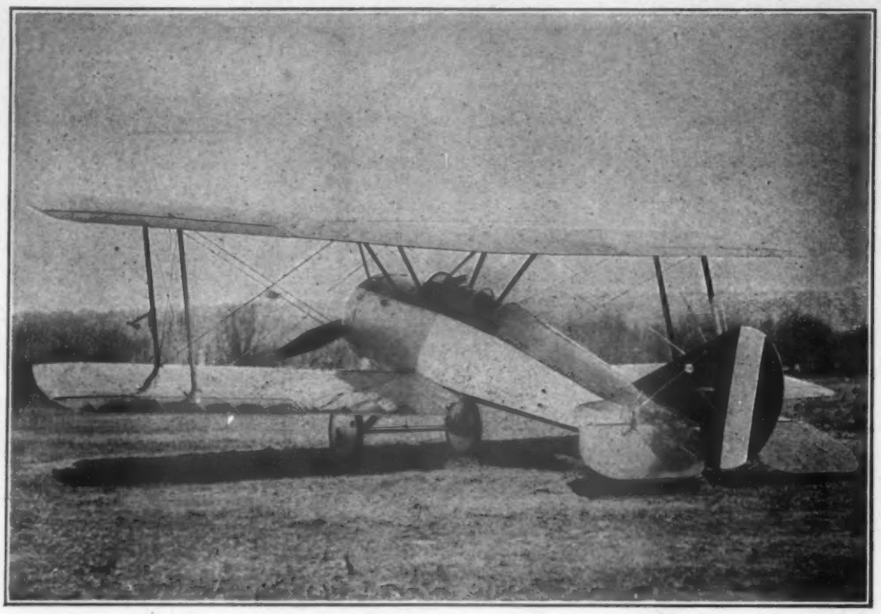

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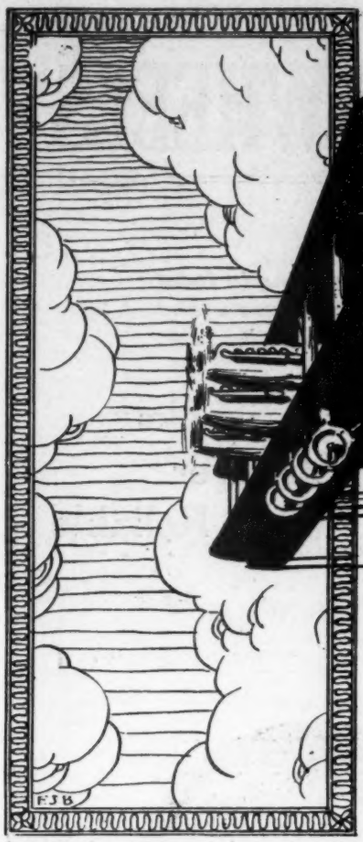

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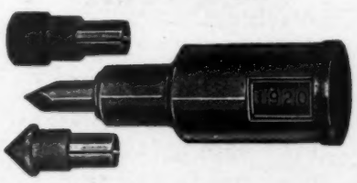

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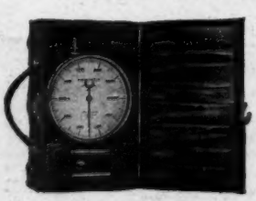

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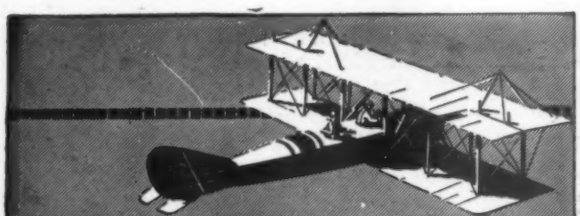

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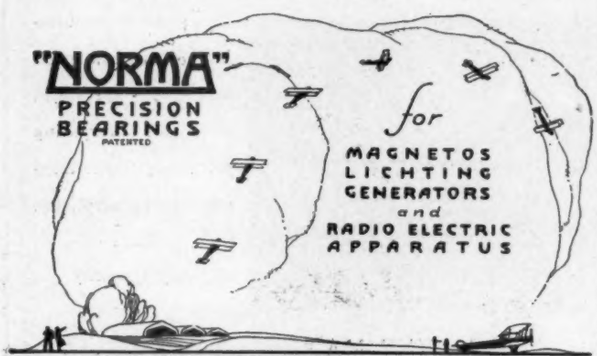

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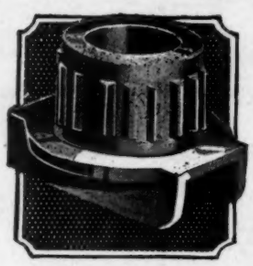

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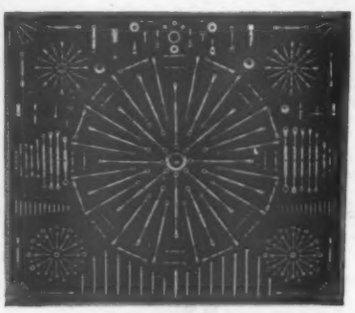

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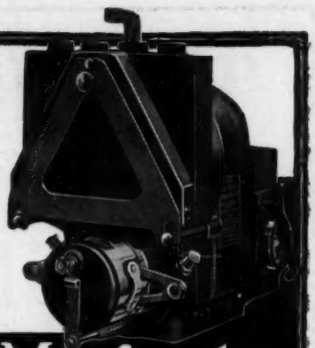

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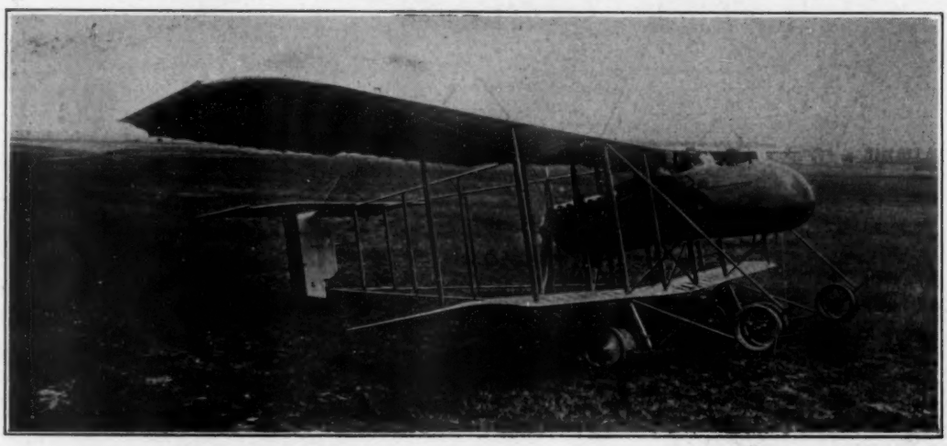

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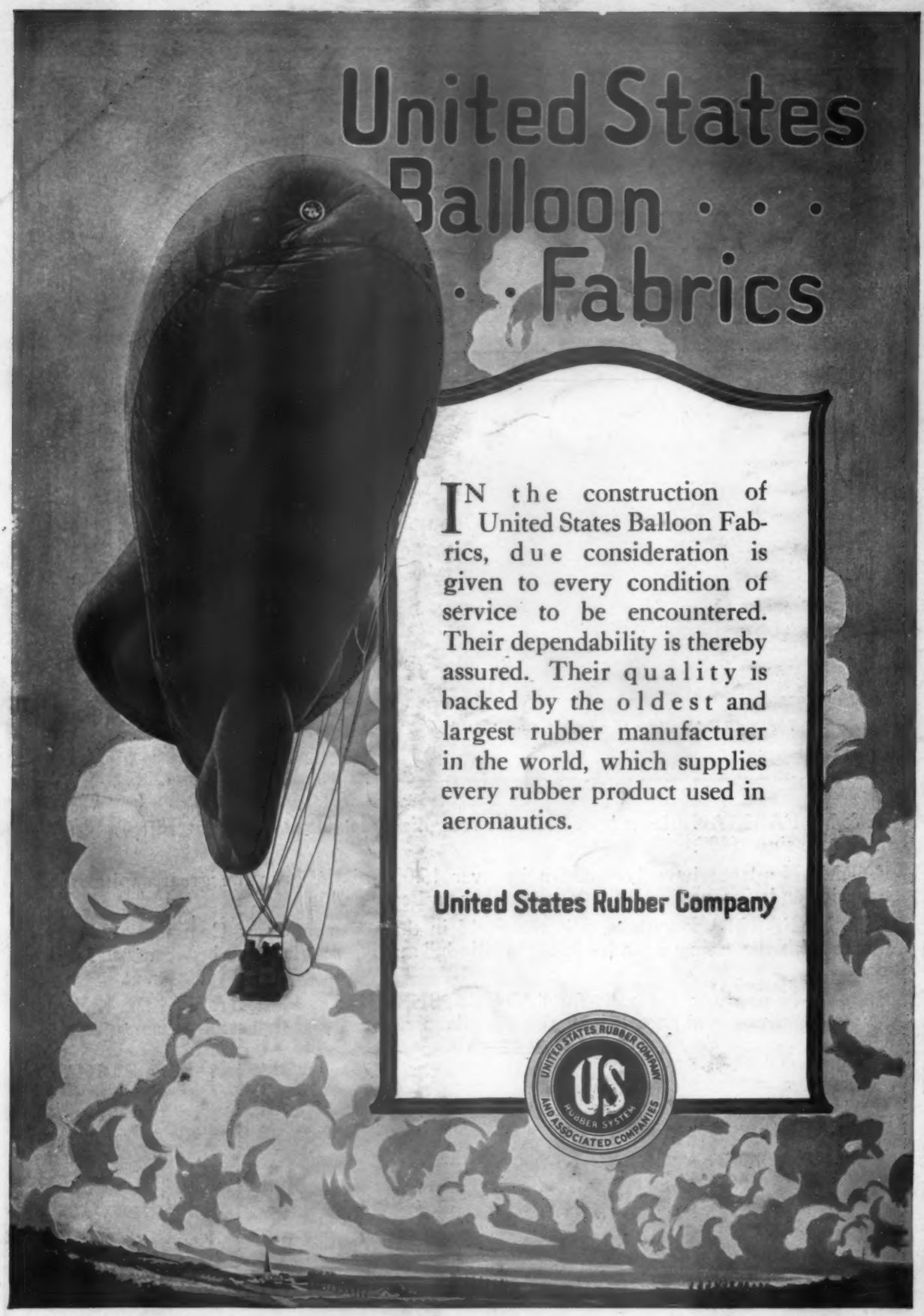
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